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An Environment to Support Negotiation and Contracting in Collaborative Networks

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To my Family

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Abstract

During the last years, manufacturing and service industries faced a global change in the production paradigm. They have to continuously adapt their operating principles in reaction to new business or collaboration opportunities, where a natural reaction is a shift to a new business paradigm with the creation of strategic alliances for product or services development, but also for innovative and emergent business services design. On one hand, the process of creating such alliances can be rather simple if organizations share the same geographical and cultural context. But on the other hand, considering different conditions, there might be a low success rate in the creation of successful consortia. One known reason for such low rate are the delays resulting from negotiations in the establishment of collaboration commitments, represented by contracts or agreements, which are crucial in the creation of such alliances.

The collaborative networks discipline covers the study of networks of organizations specially when supported by computer networks. This thesis contributes with research in this field describing the creation process of virtual organizations, and proposing a negotiation support environment to help participants in the negotiation of the consortia creation process and in the co-design of new business services. A negotiation support environment is therefore proposed and described with its main requirements, adopted negotiation protocol, conceptual architecture, models, and software environment.

To demonstrate the feasibility of the implementation of the proposed systems, a proof-of-concept software prototype was implemented and tested using some specific scenarios. This thesis work has been validated adopting a methodology that includes: (i) validation in the research community; (ii) validation in a solar industry network; and (iii) validation by comparison analysis.

Keywords: collaborative networks, virtual organizations, negotiation, co-design, agility.

Resumo

Nos últimos anos as indústrias de manufactura e de serviços sofreram uma alteração global nos seus paradigmas de produção. Perante novas oportunidades de negócio, ou colaboração, existe a necessidade de ajustes contínuos aos seus princípios de operação. Uma reacção natural, baseia-se na adopção de um novo paradigma alicerçado na criação de alianças estratégicas para o desenvolvimento de produtos ou serviços, mas também no desenho de serviços emergentes e inovadores. Se as organizações partilharem o mesmo contexto geográfico e cultural, o processo de criação das alianças estratégicas pode ser relativamente simples. No entanto, em condições diferentes, a taxa de sucesso na criação de tais alianças pode ser baixa. Uma razão conhecida para essa baixa taxa de sucesso, e fundamental na criação de alianças, resulta dos tempos envolvidos na negociação para o estabelecimento de compromissos colaborativos representados por contratos ou acordos.

A disciplina de redes colaborativas cobre o estudo de redes de organizações, particularmente quando suportadas por redes informáticas. Esta tese contribui com investigação nesta área, descrevendo o processo de criação de organizações virtuais, e propondo um ambiente de negociação, que suporte os participantes no processo de negociação para a criação de consórcios e em situações de *co-desenho* de novos serviços de negócio. É proposto e descrito um ambiente de suporte à negociação com os seus principais requisitos, protocolo de negociação adoptado, arquitectura conceptual, modelos, e ambiente de *software*.

Foi implementado uma prova de conceito na forma de protótipo de *software* para demonstrar a viabilidade da implementação dos sistemas propostos. O trabalho apresentado nesta tese foi validado através de uma metodologia que inclui: (i) validação na comunidade científica; (ii) validação numa rede de indústria solar; e (iii) validação por análise de comparativa.

Palavras-chave: redes colaborativas, organizações virtuais, negociação, co-desenho, agilidade.

Table of Contents

List of Figures

List of Tables

List of Definitions

List of Acronyms

ACL	Agent Communications Language
B2B	Business to Business
BO	Business Opportunity
BPMN	Business Process Model and Notation
BS	Business Service
CN	Collaborative Network
CO	Collaboration Opportunity
COC-Plan	Collaboration Opportunity Rough Planning Tool
CoDeN	Services Co-Design Negotiation Environment
COFinder	Collaboration Opportunity Identification Tool
DB	Database
DSA	Digital Signature Algorithm
ebXML	Electronic Business Extensible Markup Language
ECDSA	Elliptic Curve Digital Signature Algorithm
EER	Enhanced Entity Relationship
e-Notary	Electronic Notary and Registry System
ICT	Information and Communication Technology
IDE	Integrated Development Environment

ISO	International Organization for Standardization
KQML	Knowledge Query and Manipulation Language
NegAE	Negotiation Agreement Editor
NegPA	Negotiating Partners' Risk Assessment
NegSAE	Negotiation Support for Agreement Establishment
NegTM	Negotiation Templates Management
NSS	Negotiation Support System
PSS	Partners Search and Suggestion Tool
PVC	Professional Virtual Community
R&D	Research and Development
RSA	Rivest-Shamir-Adleman algorithm
SDAE	Service Design Agreement Editor
SME	Small and Medium Enterprise
UML	Unified Modeling Language
VBE	Virtual Organization Breeding Environment
VNS	Virtual Negotiation Space
VO	Virtual Organization
WfMC	Workflow Management Coalition
WizAN	Agreement Negotiation Wizard
WPDL	Workflow Process Definition Language
XML	Extensible Markup Language

1

Introduction

This thesis addresses a negotiation support environment for collaborative networks. This chapter introduces the problem domain and motivation for the proposed research work, leading to the research question and corresponding hypothesis. The chapter also includes a description of the research context in which the work was accomplished, and finishes with an outline of the dissertation.

1.1 Problem Domain and Motivation

As a result of persistent market turbulence, organizations (e.g. enterprises and other entities) have to continuously adapt their operating principles to search, face and act in response to new collaboration opportunities (e.g. business, social, or others) in order to survive and remain competitive in a globalized world. However, in many cases, due to limitations in skills and resources, organizations might not be able to react alone, and a natural strategy is a shift to a new business paradigm where the creation of strategic alliances is vital (Bititci et al., 2007).

During the last decade, in manufacturing and service industries, collaboration among small and medium enterprises (SMEs) has focused on competences and resources sharing (Husdal, 2010) as an approach to both create new competitive environments, as well as to achieve agility to rapidly respond to market demands. Working in collaboration typically implies sharing the opportunities and gained profits, as well as risks and losses. Such sharing might increase the survival chances of SMEs.

For this purpose, organizations should adapt their strategies and operational principles, adopting an infrastructure that allows them to become more prepared for working together.

The concept of collaborative network (CN), and more specifically virtual organization (VO), appears particularly well suited to cope with very dynamic and turbulent market conditions. This is due to the possibility of rapidly forming a consortium, triggered by a collaboration opportunity and specially tailored to the requirements of that opportunity (Camarinha-Matos et al., 2008a). Implicit in this concept is a notion of *agility*, allowing rapid adaptation to a changing environment.

Finding the right partners and establishing the necessary conditions for starting a collaboration process have however proved to be costly in terms of time and effort (Li et al., 2008), and therefore an inhibitor of the aimed agility. First, a VO planner might face lack of information about the profile and competences of potential partners. Furthermore, the actual capacities and willingness to get involved in a consortium are dynamic and might depend on a negotiation process (Hagel and Brown, 2005). Second, collaboration might be hindered by mismatches due to different infrastructures used by different partners, different business cultures and methods of work, different expectations, lack of trust, etc. (Lin and Malhotra, 2012). Overcoming these mismatches is time consuming and therefore an obstacle for rapid consortium formation. Third, making a decision on which partner to select for each needed task depends not only on characteristics such as competences, resources, etc., but also on past performance in collaborative processes, capability to work together with the other partners, and the preferences of the VO planner (Camarinha-Matos and Afsarmanesh, 2007; Jarimo and Salo, 2009).

Furthermore, depending on the different application domains or on the different objectives, VOs may appear in a variety of forms, with a variety of behavioral patterns (Camarinha-Matos and Afsarmanesh, 2008a). Thus, due to these possible varieties, it is also essential to take into account each context and its fundamental characteristics, namely during the negotiation processes that have to be adaptable to each specific case.

Having introduced the context and focus of the problem, what are then the main issues that organizations face when creating VOs? For example, in the industrial sector, the 'quotation request' business process is a challenging task for every company involved in contracting activities, as potential customers have nowadays access to a very large global market. As a consequence (Oliveira et al., 2010):

- The success rate of a quotation (transformation into an order) lays around 10%. In other words, it means that 9 out of 10 quotation preparations are only a waste of time and money;
- The profit margins are reduced and thus the price calculations must be very accurate; and
- Often the quotation must be ready in a very short time, as competitors also react quickly.

The delays induced in a VO creation process are mainly the result of having to deal with several critical issues (Camarinha-Matos et al., 2008b), such as:

- Finding / choosing the right partners;
- Coping with the lack of common templates or standard formats for basic profile information about organizations;
- Developing and agreeing on the common principles of sharing and working together;
- Establishing trust among organizations;
- Defining the agreements on the roles and responsibilities of each partner, to reflect sharing of tasks, rights on the produced results, etc.; and
- Coping with the lack of preparedness of organizations to collaborate.

Some of these problems can be mitigated through the concept of virtual organizations breeding environment (VBE) (Afsarmanesh et al., 2008b). Nevertheless, issues of negotiation and time reduction in consortia formation are not completely supported by current infrastructures available to these VBEs. A key issue here is the additional delays induced by the participation of many potential partners and the need to negotiate until an agreement is reached. These delays are not too critical in the case of a small local CN, where the members share the same language and business background and could probably solve their problems by using traditional communication methods like e-mails, face-to-face meetings, and phone calls. The situation is however completely different for multicultural and geographically wide spread networks. For these cases, there is a need to improve the effectiveness of the negotiation processes during the formation of virtual organizations. Therefore, it is important to consider a negotiation environment that enables organizations to conduct their negotiation processes following a simple and easy approach.

1.2 Research Question and Hypothesis

The main aspect that is considered in the proposed research work is how the creation of VO consortia can be improved with the aid of a negotiation methodology, namely when dealing with market turbulence, low success rate of collaborative consortia, and natural delays introduced by the negotiation process. These three aspects are particularly significant:

- **Market Turbulence**: the possibility of rapidly forming virtual organizations to respond to a collaboration opportunity gives companies an expression of agility and survival mechanisms in face of the market turbulence;
- **Low Success Rate**: when facing market conditions, the consortia quotation process is very difficult, and a huge number of potential consortia fail. Any attempt to reduce potential risks at this stage may represent considerable gains; and
- **Delays in Negotiation**: the main drawback in the case of collaborative networks, is the supplementary delays caused by the participation of many partners, possibly located in diverse geographical regions, and the need to negotiate until an agreement is reached. Improvements in the duration of this process might be determinant for the materialization of the collaboration opportunity.

In this context, this research work aims at contributing to the creation of an electronic environment that enables organizations to effectively conduct their negotiation processes towards the creation of VOs. As such, the main research question is:

How can an electronic negotiation support environment increase agility in the process of creating successful dynamic virtual organizations?

Whereas the term *agility* is defined as follows:

Definition 1. Agility

Agility is the ability to quickly and efficiently adapt to a changing environment while attempting to achieve an objective.

Being the main objective to achieve an adequate negotiation support environment to facilitate the process of creating successful virtual organizations, the following related sub-questions complement the main research question:

Sub-Question 1.	Under which conditions can agility be achieved in the creation of VOs?

Sub-Question 2.	How can a VO agreement be created and represented to increase the effectiveness of the VO creation process?

Sub-Question 3.	Which key elements can be considered in the VO creation process to increase its the level of success?

To provide a possible solution for each of the research questions, corresponding hypotheses were formulated.

Hypothesis 1.	If the VO creation process takes place in a virtual organization breeding environment context, which allows rapid adaptation to changing environments, then the notion of agility is covered.

Hypothesis 2.	If the VO agreement is created and represented using electronic means, then a faster and cheaper solution than standard paper-based contracting can be accomplished.

Hypothesis 3.	If the negotiation process considers and assesses the related risk sources and drivers of consortia creation, then the potential for risks during collaboration is likely to decrease.

Considering the above, the **main hypothesis** adopted for this work is:

The process of creating dynamic virtual organizations can become more agile if an appropriate electronic negotiation wizard environment is established to structure and conduct the entire negotiation process, making it traceable, and reducing the collaboration risks.

Moreover, the negotiation environment should be customizable according to different collaboration levels, either in terms of commitment, duration, or context.

1.3 Research Context

The research addressed in this thesis was partially done in the context of two European funded research projects: ECOLEAD (ECOLEAD, 2004-2008) and GloNet (GloNet, 2011-2015).

Both projects substantially contributed to the accomplishment of the proposed research work as follows:

- In a first stage, the ECOLEAD project provided the definition of the problem that motivated the proposed research and supported the initial developments. At a second stage, the GloNet project extended the solution to the problem, what allowed enhancing the proposed work.
- Both projects provided direct interaction with relevant stakeholders/experts in the area of collaborative networks in different application domains, what was relevant for requirements identification and assessment of the results.
- Both projects provided direct interaction with real networks of organizations that were part of the projects' consortia. In ECOLEAD the most relevant networks for this work were:
  - Swiss Microtech (Swiss Microtech Enterprise Network, Switzerland), a network of manufacturers of high precision components;
  - ISOIN (Spain), representing a network of companies operating in the new technologies sector, namely in the aeronautics sector. It facilitates the development of multiple international partnerships;
  - CeBeNetwork (Germany), representing a network of engineering companies that offer integrated solutions for services and products in the air transportation field, namely in cabin, flight physics, systems and structures. During the duration of this PhD, CeBeNetwork was integrated in Voith Industrial Services; and
  - IECOS (Mexico), a network of SMEs providing engineering services in the area of electro-mechanical products and systems;

  while in GloNet there was a great interaction with iPLON (iPLON GmbH The Infranet Company, Germany) that represents a network of companies in the area of solar industry.
- Both projects contributed with valuable assessment of the work carried out during the project duration, namely through project reviews, end-users opinions, and pilots implementation.

  Below is a small overview of both research projects.

1.3.1 ECOLEAD Project

The proposed research work started during the ECOLEAD: *European Collaborative Networked Organizations LEADership initiative*, project funded by the European Commission under the ICT programme (6º FP – IP 506958, 2004-2008). The project had a duration of 51 months, involving twenty-eight partners from fourteen countries through Europe and Latin America.

ECOLEAD aimed at creating strong foundations and mechanisms to establish an advanced collaborative and network based industry society in Europe (Camarinha-Matos et al., 2005a; Camarinha-Matos, et al., 2008a). For that, the project addressed three fundamental and inter-related focus areas, constituting the ECOLEAD pillars, as the basis for dynamic and sustainable networked organizations, including: virtual organizations breeding environments (VBEs), dynamic virtual organizations (VOs), and professional virtual communities (PVCs):

- **Virtual Organizations Breeding Environments**: focus area aimed at understanding and formalizing the main operating principles of VBEs during their life-cycle. This area included the conceptualization of: *generic VBE models and mechanisms; VBE management system*; and *VO creation framework*. It was mainly under this focus area that part of this work took place.
- **Dynamic Virtual Organizations**: focus area aimed at developing models to support the VO management. This area included: *VO performance measurement approach and assessment mechanisms*; *VO management, coordination and supervision*; and *VO inheritance and pro-active management*.
- **Professional Virtual Communities**: focus area aimed at leveraging human centered communities management and exploitation of individuals' knowledge for value creation within PVCs. This area included *collaboration models and social forms*.

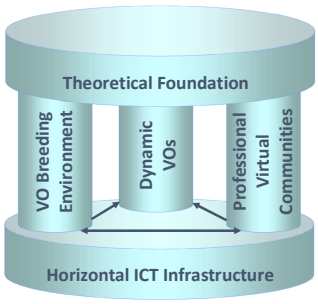

Figure 1.1. The ECOLEAD project pillars (Camarinha-Matos, et al., 2005a)

The ECOLEAD pillars were supported on and reinforced by two horizontal development lines:

- **Theoretical Foundation**: focus area aiming at establishing foundations for CNs to be recognized as a scientific discipline. It included *formal modelling foundation*; *reference models for collaborative networks*; *soft models for collaborative organizations;* and *basis for combination of models*. Some theoretical aspects of this thesis also benefited from his area.
- **Horizontal ICT Infrastructure**: focus area aiming at developing an ICT infrastructure to support networked organizations. It included *infrastructure reference framework; infrastructure business models; security framework; and ICT SOA-oriented infrastructure for collaboration*.

1.3.2 GloNet Project

The proposed research work was continued with GLONET: *Glocal Enterprise Network Focusing on Customer-Centric Collaboration* (http://www.glonet-fines.eu/), project funded by the European Commission under the ICT-FoF programme (7º FP – 285273, 2011-2015). The project had a duration of three and a half years and involved eight partners from six countries in Europe, and some collaboration in India.

GloNet aimed at designing, developing, and deploying an agile virtual enterprise environment for networks of SMEs involved in highly customized and service-enhanced products through end-to-end collaboration with customers and local suppliers (co-creation) (Camarinha-Matos et al., 2011). The project pursued the notion of *glocal* enterprise, which represents the idea of thinking and acting globally, while being aware and responding adequately to local specificities. It thus endorsed the vision of a new participative manufacturing environment supported by the Internet, hosting a new wave of services, using user-friendly technologies aimed at empowering the enterprise of the future. Achievements in this domain resulted in improved efficiency of product intelligence, enabling advanced product-centric services and new business models and capabilities for improved management of global networked operations (Camarinha-Matos et al., 2013d; Camarinha-Matos et al., 2013e; Camarinha-Matos et al., 2013f).

The main guiding use case in GloNet was focused on the production and life-cycle support of solar energy parks. The norm of operation in this industry is that of one-of-a-kind production. The results (products and services) are typically delivered through complementary competences shared between different project participants. A key challenge here is the design and delivery of multi-stakeholder complex services along

the product life-cycle (which typically spans over 20 years). In order to extend the applicability of GloNet results, other domains with similar abstract characteristics, such as building automation and physical incubators of enterprises, were also considered. Main focused issues included:

- Information / knowledge representation (product catalogue, processes descriptions, best practices, company profiles, brochures, etc.);
- User-customized interfaces, dynamically adjusted to assist different stakeholders;
- Services provision supported on cloud computing;
- Broker-customer interaction support: from order to (product/service) design (open innovation approach);
- Negotiation support for VO creation and for business services co-design, with a major contribution from this thesis work;
- Workflow for negotiated order solution and its monitoring; and
- Risk management, also with contributions from this thesis.

1.3.3 Other Projects

The accomplishment of the proposed research work also benefited from the author's participation in other research projects, as a member of the CoDIS research group of Uninova.

TeleCARE: *A Multi-Agent Tele-Supervision System for Elderly Care* (Camarinha-Matos and Afsarmanesh, 2004), project funded by the European Commission under the 5º Framework Programme (IST-2000 – 27607, 2000-2004). The project main objective was the design and development of a framework for tele-supervision and tele-assistance, following a federated multi-agent approach, with the goal of assisting elderly people at their home environment. It also included services to support elderly relatives and elderly care centers in the monitoring and assistance of elderly people.

The participation in this research project provided a better understanding of some notions, such as communities and networks (of people, companies, and devices/agents). The Master thesis of the author of this thesis (Oliveira, 2006) was a result of the participation and contribution in the TeleCARE research project.

ePAL: *extending Professional Active Life* (Camarinha-Matos and Afsarmanesh, 2010), project funded by the European Commission under the 7º Framework Programme (ICT-2007.7.1 – 215289, 2008-2010) as a coordination action for the development of a strategic

research roadmap focused on inducing new ways towards a balanced active life for retiring and retired professionals while promoting the notion of silver economy with a wide social impact. The result of the project was a set of roadmap recommendation actions under three distinct perspectives: social, organizational, and technological.

Through the participation in this research project, the main challenges for designing and implementing innovative solutions for senior assistance were apprehended.

BRAID: *Bridging Research in Ageing an ICT Development* (Camarinha-Matos et al., 2013c), project funded by the European Commission under the 7º Framework Programme (ICT-2009-7.1 – 2484852, 2010-2012) as a support action for the development of a comprehensive RTD roadmap for active ageing, consolidating existing roadmaps (results from previous research projects: AALIANCE, CAPSIL, ePAL, and SENIOR). The resulting roadmap intended to define a common strategic research agenda to consolidate and re-enforce EU leadership in ICT and ageing.

By participating in this research project, it was obtained an overview of the major challenges that elderly people face and the potential actions that might be taken considering four life settings: independent living, health and care in life, occupation in life, and recreation in life. Furthermore, the role of collaborative networks in this research context was analyzed in depth.

AAL4ALL: *Ambient Assisted Living for All* (AAL4ALL, 2011-2015), Anchor Project of the *Health Cluster Portugal* (*Pólo de Competitividade da Saúde*), funded by the Portuguese Government through the *COMPETE* and *Quadro de Referência Estratégica Nacional* (2011-2015). The main objective of the AAL4ALL project was to develop a large-scale ecosystem with products and ambient assisted living services to support elderly people and maintain them at their preferred environments (Camarinha-Matos et al., 2012a). The project considered the scenarios elaborated in the BRAID project.

The participation in this research project gave the opportunity to apply the proposed research work in a different application context, namely with a contribution to the conceptual architecture of the project.

1.4 Adopted Research Method

The proposed work aimed at performing fundamental and applied research in the area of collaborative networks to improve the process of creation of virtual organizations

through the usage of a structured negotiation support environment. To achieve such result, this thesis work followed the classical research method (Rajasekar et al., 2006; Camarinha-Matos, 2009), that consists of seven main phases, as illustrated in Figure 1.2.

Figure 1.2. Classical research method, adapted from (Camarinha-Matos, 2009)

Following this method, the research work was planned and scheduled according to the seven main phases:

- **Research Question / Problem:** identification of the working context and motivation to formulate the research question;
- **Background / Observation:** analysis of the state of the art in research and practice. In this observation and analysis, some main topics are addressed, namely: related background and existing requirements in collaborative networks, specifically VOs and their related environments; methods for consortia creation; business to business contracting; contracts and agreements for collaborative networks; and business services design;
- **Formulate Hypothesis**: formulation of the hypothesis according to some preliminary analysis of the main problem and the current state of the art;
- **Design Experiment**: split into two phases: first the development and implementation of a negotiation tool that supports the creation phase of VOs, followed by the development and correspondent implementation of a structured negotiation tool considering the previous results and new characteristics. The

result is the design of a framework, system architecture, and validation scenarios. These three aspects are described below:

- Framework for inter-community negotiation in collaborative networks, including the development of a conceptual basis for different negotiation processes considering: the different actors, roles, and objectives of different collaborative environments.
- System architecture that envisages inter-community negotiation, i.e. different levels of negotiation among participants of one or more communities and/or consortia. Specification of models and functionalities for online notary certification, authentication, and contracting are also considered.
- Validation scenarios with the characterization of the basic scenarios to validate the developed concepts.

— **Test Hypothesis / Collect Data:** application of the proof-of-concept prototypes to the validation scenarios. Results are collected for analysis and evaluation.

— **Interpret / Analyze Results**: analysis and evaluation of the model, methodology and proposed tools in selected validation scenarios.

— **Publish findings**: in parallel to all previous phases, there is a continuous publishing of the work findings, in recognized conferences and journals, being the work finalized with this thesis document, combining all the findings that were published and the final remarks.

Although the described phases might give the impression of a sequence, there are some iterations among them. As an example, after implementing, testing and interpreting some results, there was the need to make some reformulation in the hypothesis and corresponding model design to achieve results that are more accurate.

1.5 Thesis Outline

This thesis document is divided into seven chapters and some supporting annexes:

— **Chapter 1. Introduction:** Introduces the problem domain and motivation for the proposed research work, a negotiation support environment to enhance and improve the creation of virtual organizations. This leads to the main research question and corresponding hypothesis. The chapter also includes a description of

the research context: the European research projects ECOLEAD and GloNet; and finishes with this thesis document outline.

— **Chapter 2. Background and Literature Review:** Introduces a literature review in related areas, providing a baseline for the proposed research work. The most relevant area for this work is the collaborative networks discipline, with special relevance for the creation of virtual organizations and their breeding environments. In addition, the electronic negotiation and contracting areas are of the most importance for this work. Some other related areas are also considered, such as business services design. Therefore, the sections of this chapter present an outline and discussion on the relevant background areas, and review how they are related to the focus of this work, identifying current research gaps/challenges.

— **Chapter 3. Virtual Organization Creation:** Discusses the concept of virtual organization, focusing on its creation stage. It comprises the VO recruitment spaces and VO creation process. The involved actors and roles, as well as the main business processes involved in the VO creation process are also analyzed, leading to a proposal for a conceptual architecture for VO creation. This specific work is an outcome of the results of both ECOLEAD and GloNet projects to which the author of this thesis actively contributed. Additionally, in this chapter, an electronic notary system is proposed with the aim of providing notary and registry functionalities to assist in the negotiation process of VO creation.

— **Chapter 4. VO Negotiation Environment:** Presents the main contribution of this research work, the negotiation environment for VO creation. It describes the main requirements, life-cycle, actors and roles, and the adopted negotiation protocol. To cover different contexts, a negotiation support environment is proposed both for the traditional VO creation, and also for the co-design of innovative business services.

— **Chapter 5. Proof-of-Concept Implementation:** Describes the software prototype designed and developed to support the proposed electronic notary and registry system, described in chapter 3; as well as the negotiation support environment for VO creation and for business services co-design, described in chapter 4.

— **Chapter 6. Validation:** Addresses the validation of the thesis work. It includes a three-level validation methodology based on: *validation in scientific community*, with the integration in EU research projects and peer validation; *validation in solar industry network*, aiming at gathering evidences of the general fitness of the proposed solutions in real scenarios; and *validation by comparison*, comparing the main proposed systems and functionalities with available/emerging solutions on the market.

— **Chapter 7. Conclusions and Future Work:** Presents a summary of the findings and concludes the thesis document. The chapter also includes some possible directions for further research.

2

Background and Literature Review

This chapter introduces a literature review in related areas that provide a baseline for the proposed research work. The collaborative networks discipline, with special relevance for the virtual organizations creation and their breeding environments, namely the virtual organizations breeding environments, is the most relevant area for this work. In addition, also important areas for this research work are the electronic negotiation and contracting. Some other related areas are also considered, as is the case of business services and their design. Therefore, the sections of this chapter present an outline and discussion on the relevant background areas, and review how they are related to the focus of this work, identifying current research gaps or challenges.

2.1 Collaborative Networks

As stated in the introductory section, in order to respond to competitive market requirements, organizations may follow a new business paradigm based on the creation of strategic alliances, or networks of organizations (Camarinha-Matos et al., 2005b; Niemann et al., 2008). This paradigm comes as a reaction to more complex market requirements, where organizations would not be able to act alone in response to those requirements (Partanen et al., 2014). Previous works have recognized a number of reasons for organizations to establish such networks, including:

- Flexibility and capacity, by being able to gain access to, and quickly allocate, a range of each other's resources (Stuart, 2000; Child et al., 2005);
- Speed, by being able to quickly respond to a wide range of collaboration opportunities (Jarillo, 1995);

— Business intelligence, by sharing market information (Husdal, 2010).

Furthermore, (Borgatti and Foster, 2003) and (Fjeldstad et al., 2012) also point out most of these reasons and add some others such as: reduce risks, decrease costs of development, etc. but, most importantly, increase the value creation (Doloreux and Shearmur, 2012).

In networks of organizations, the approach to perform activities, and share responsibilities and information can depend on the level of joint working. Figure 2.1 illustrates some different joint working levels that can be found in some networks of organizations (Camarinha-Matos and Afsarmanesh, 2008a; Lozano, 2008).

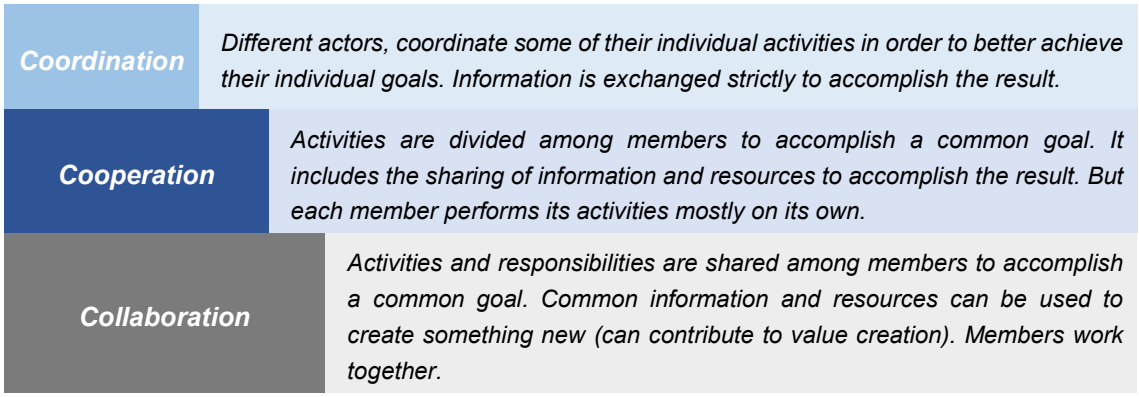

Figure 2.1. Different working levels in networks of organizations

Different classifications for networks of organizations can be found in literature, namely according to the duration of the collaboration and dependency among involved actors, but also according to their different topology (Katzy et al., 2005; Camarinha-Matos and Afsarmanesh, 2008a). Figure 2.2 illustrates a partial classification according to the network topology: (i) *chain topology*, where partners' interaction follows a defined route process; (ii) *star topology*, where there is a dominant member; and (iii) *general network topology*, where there are multiple interactions among all member nodes.

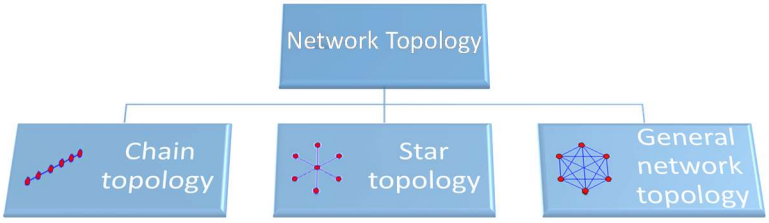

Figure 2.2. Examples of classification of networks of organizations according to topology

On the other hand, considering some authors in the area, such as Westkamper and Camarinha-Matos, Figure 2.3 illustrates other examples of classification of networks of classification according to their duration and their actors' dependencies.

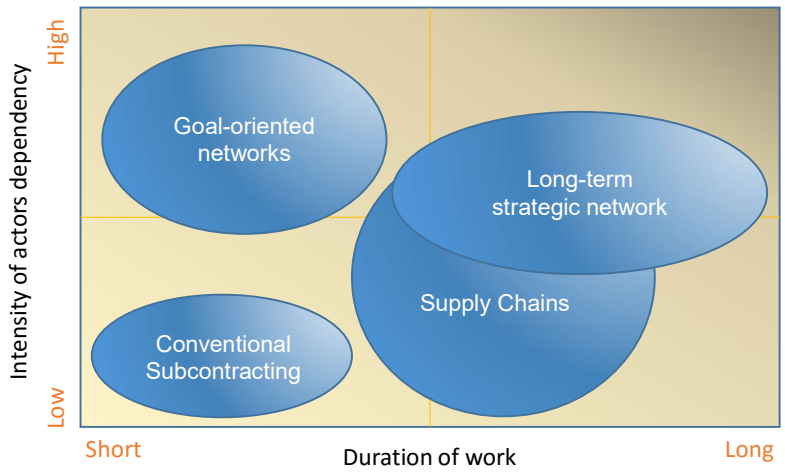

Figure 2.3. Examples of classification of networks of organizations according to duration and actors' dependencies, adapted from (Westkämper and Tutsch, 1998; Camarinha-Matos and Afsarmanesh, 2008b).

The classification shown in Figure 2.3, ranges from the conventional subcontracting to the long-term strategic networks, as the virtual organizations breeding environments. The conventional subcontracting include simple *coordination* actions, while supply chains can both imply *coordination* and *cooperation* actions in an environment that is typified, and where the involved actors have well defined roles in the process (Mentzer et al., 2001; Camarinha-Matos et al., 2009a). There are however, trends in sustainable supply chain management to introduce organizational changes in supply chain structures. These changes allow more competitive production towards satisfying customers/market requirements (Turker and Altuntas, 2014), but at the same time, provide value creation (Carvalho and O'Neill, 2014) and correspond to a move along the vertical axis. Regarding long-term strategic networks, there is substantial *cooperation* among its members to guarantee an environment to support rapid configuration of goal-oriented *collaborative* networks (Camarinha-Matos and Afsarmanesh, 2008b).

The *collaborative networks* (CN) concept was proposed by Camarinha-Matos and Afsarmanesh (2005) as a scientific discipline that covers the study of "*networks consisting of a variety of entities that are largely autonomous, geographically distributed and heterogeneous, and that collaborate to better achieve common or compatible goals, and whose interactions are*

supported by computer network". In this line, the proposed work follows a collaborative networks classification that was introduced by these two authors in the scope of the ECOLEAD research project. Figure 2.4 partially summarizes this classification, but also introduces new manifestations of collaborative networks that were defined in later works, namely in the GloNet research project.

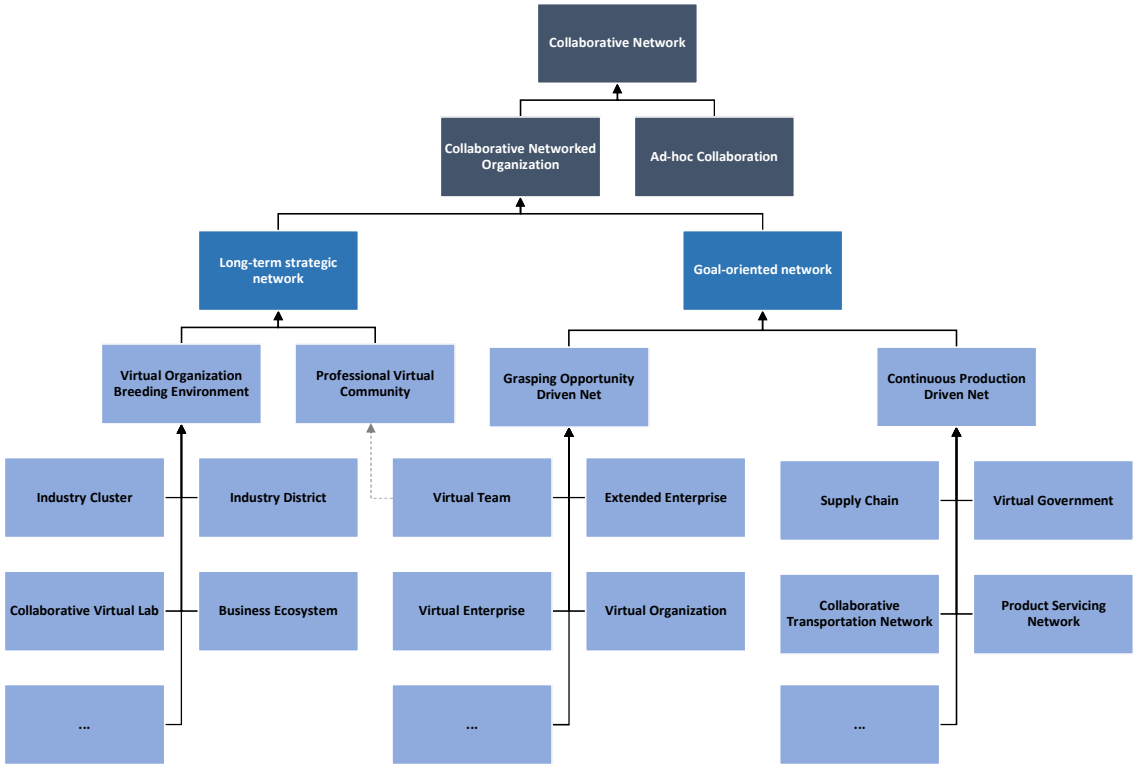

Figure 2.4. Partial collaborative networks taxonomy, adapted from (Camarinha-Matos and Afsarmanesh, 2008b; Camarinha-Matos, et al., 2013f)

Table 2.1 includes brief definitions of relevant forms of CNs (Camarinha-Matos and Afsarmanesh, 2008b; Camarinha-Matos, et al., 2013f) that are related for the work proposed in this thesis.

Being the main goal of this work to contribute with an electronic environment to enable organizations to conduct negotiation processes towards the creation of virtual organizations, section 2.1.1 further details the concept of virtual organization and its related environment.

Table 2.1. Definitions of different forms of CNs.

CN Type	*Definition*
Collaborative Networked Organization	Represents a collaborative network possessing some form of organization in terms of membership structure, activities, definition of roles of the participants, and follows a set of governance principles and rules.
Ad-Hoc Collaboration	Represents a spontaneous form of collaboration without a precise structure or pre-defined organization.
Long-term Strategic Network	Represents a strategic alliance that is established with the purpose of being prepared for participation in collaboration opportunities. It is aimed at offering the conditions and environment to support rapid and fluid configuration of collaborative networks, when opportunities arise.
Goal-Oriented Network	Represents a collaborative network in which intense collaboration (towards a common goal or set of compatible goals) is practiced among its partners.
Virtual Organization Breeding Environment	Represents an association of organizations and a number of related supporting institutions, adhering to a base long term cooperation agreement, and adopting of common operating principles and infrastructures, with the main goal of increasing their preparedness towards rapid configuration of temporary alliances for collaboration in potential virtual organizations.
Grasping Opportunity Driven Network	Represents a temporary alliance of independent organizations that is established in a short time to respond to a single collaboration opportunity. Typically, this alliance has a short life-cycle dissolving after the goal is accomplished. Also defined as *Goal-oriented Networks*.
Continuous Production Driven Network	Represents a temporary alliance of independent organizations that is established in a short time to respond to a single competitive market collaboration opportunity. Typically, this alliance has a long life-cycle, dissolving after the goal is accomplished. Also defined as *Long-term Virtual Organization*.
Virtual Organization	Represents a set of individual organizations (not limited to profit enterprises) that share resources and skills to achieve its goal.

2.1.1 Virtual Organizations Creation and their Environments

During earlier research on collaborative networks, the virtual organization (VO) creation process has received considerable attention. However, most of the proposals and developments, at that time, were aimed at designing a fully automated process and frequently based on a set of simplistic assumptions.

The virtual organization (and its counterpart virtual enterprise) paradigm constitutes one of the first manifestations of the collaborative networks. Being the concept developed and applied to several domains and areas, many contributions for

the characterization and modeling of the paradigm can be found in the literature, as exemplified in (Bititci, et al., 2007; Camarinha-Matos and Afsarmanesh, 2008c; Camarinha-Matos, et al., 2008a; Parung and Bititci, 2008; Mehandjiev and Grefen, 2010; Hanebuth, 2015; Priego-Roche et al., 2015). The main idea behind this concept is basically of a temporary consortium of enterprises and/or organizations, geographically dispersed, that strategically join their competences to rapidly respond to a collaboration opportunity, typically supported by computer networks, and that dissolve after achieving their goal (Camarinha-Matos and Afsarmanesh, 2003; Camarinha-Matos et al., 2005c).

Agent-based approaches. For example, a large number of works have been published on the application of multi-agent systems and market-oriented negotiation mechanisms for VO creation. One early example can be found in (Rocha and Oliveira, 1999), which assumes a virtual market place where enterprises, represented by agents, can meet each other and cooperate in order to achieve a common business goal. A similar work is found in (Li et al., 2000) where a more detailed analysis of the problem of goal decomposition, leading to a hierarchy of VO goals, is done. The work described in (Shen and Norrie, 1998) identifies the need for yellow pages agents that are responsible for accepting messages for registering services. (Kaihara, 1999) elaborates further on the application of market-oriented principles, such as the general equilibrium in micro-economics. In this line, (Reis et al., 2001) propose a model for a multi-agent cooperative scheduling system for an extended enterprise context. Also, (Barradas and Pinto-Ferreira, 2004) propose a P2P infrastructure for a distributed e-marketplace for the tourism sector. (Volpentesta and Muzzupappa, 2005) developed a collaborative approach supported by multi-agent systems for the formation of virtual enterprises in a conceptual design knowledge e-market, where the goal is the transaction on knowledge-professional services or knowledge products.

(Cardoso et al., 2007), propose a virtual normative environment using agents that represent real world entities, to assist and regulate the creation of virtual organizations. In this line, focusing on partners selection, (Urbano et al., 2012) introduce a method based on mutual trust and normative control to apply sanctions. Although the proposed model is not static and includes great level of complexity, it does not include other criteria. For vast collaborative environments, especially not geographically bounded, the inclusion of other business-oriented criteria might be relevant.

To allow companies to make bids regarding business opportunities, (Hsieh and Lin, 2012) propose a combinatorial reverse auction mechanism as a way to minimize the cost of a virtual enterprise formation. It enables several bidders to bid efficiently on

different combinations of goods with a combined price according to their available goods and capabilities. In this way, it is possible for a buyer, or a VO planner, to arrange bid winners more effectively.

More recently, (Garcia et al., 2016) developed the ROMAS (regulated open multi-agent systems) methodology to analyze and design virtual enterprises. The approach relies on an autonomous agents environment, where agents represent enterprises that operate in normative contexts.

In case the VO is already in its operation phase and a partner needs to be replaced, (Shadi and Afsarmanesh, 2014), propose a framework to enable monitoring the trustworthiness level of the involved agents as a fuzzy norm with the aim of supporting the VO coordinator to find suitable candidates.

Service-based approaches. Another line of work is the service-federation approach or implicit VO creation. According to this approach, companies (potential members of the virtual organization) are considered as "service providers", i.e. the potential collaborative behavior of each company is "materialized" by a set of services. Services are selected and composed in order to satisfy the needs of the collaboration opportunity and therefore the providers of those services implicitly form the VO (Camarinha-Matos et al., 2001). An early case of such line of work is the case of the Fetish project (Afsarmanesh and Camarinha-Matos, 2000) which introduced service-oriented approaches to VOs in the tourism sector, through a system called federated Web-based Tourism Information System (WTIS). Another example is given by the OSMOS project (Rezgui, 2007), which was focused on the construction industry and followed a service-based approach for the design and development of its ICT infrastructure. Moreover, (Kutvonen et al., 2008) introduced the Pilarcos architecture that addresses the needs of managed collaboration and interoperability of autonomous business services in an inter-organizational context. Using a federated approach, the Pilarcos B2B middleware was then designed for lowering the cost and effort of collaboration establishment and to facilitate the management and maintenance of electronic business networks. A conceptual model for service procurement in collaborative networks, focusing on trust relationships between buyer and providers, is proposed by (Herfurth and Weiß, 2010). Also, (Cardoso and Camarinha-Matos, 2013) propose the PASEF framework for the creation of a services ecosystem aiming at pro-actively find and pursue collaboration opportunities.

Optimization-oriented approach. Other researchers put the emphasis on formulating the VO creation as an optimization problem, considering levels of uncertainty and risks

(Crispim and Sousa, 2009). Several authors present integer programming models where the objective is to minimize total costs, including production, operation, and transportation (Ko et al., 2001; Ip et al., 2004; Wu and Su, 2005; Zhao et al., 2008; Tao et al., 2010; Dao et al., 2014). However, it has been recognized that VO creation is essentially a multi-criteria decision-making problem, including also soft factors such as corporate culture, personal preferences, mutual trust, level of preparedness, and learning ability, which are not incorporated in pure cost models. Responding to this challenge, other earlier works present some multi-criteria models, which however seem to lack one important issue, namely explicit modeling of inter-organizational relations between partner candidates (Mikhailov, 2002; Boon and Sierksma, 2003; Sha and Che, 2005). Also, in (Johnson et al., 2009; Johnson et al., 2010) there is a description of the technical and social perspectives of the complexities that large collaboration groups include. Considering the partner selection for the virtual organizations as a multi-criteria decision making problem, (Crispim and Sousa, 2007, 2009) propose an integrated approach to rank alternative VO configurations using an extension of TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) for fuzzy data. Different criteria can be considered such as the probability of satisfying demands and due dates (Crispim et al., 2015).

Further addressing the partners' selection problem, (Niu et al., 2012) propose an approach with five attributes (cost, time, quality, reputation, and risk) considering both qualitative and quantitative aspects to evaluate the candidate partners. In addition, a model for integration of partner selection and collaborative transportation scheduling in virtual enterprises is proposed by (Dao, et al., 2014), adopting a genetic algorithm.

Nevertheless, most of the proposed optimization solutions tackle the specific aspect of partners' selection and not the entire process of virtual organization creation.

Partners' selection in the context of a VBE. As a solution for some obstacles in VO formation, both research and practice have shown that the pre-existence of long-term associations/clusters can greatly enhance the efficient creation of VOs, in response to emerged opportunities. In this direction, during the last years, "clusters" have been formed by organizations typically located in a common region, since geographical closeness still represents several advantages for collaboration, such as common adoption of the local culture and facilitating the creation of trust and "sense of community". With the development of more effective communication infrastructures, clusters started to step beyond the geographical regions in order to access new competences and new market opportunities. Therefore, long-term clusters/associations, which are not necessarily bound by geographical closeness, led to the concept of virtual organizations

breeding environment (VBE), that was introduced to address many new challenges involved in the establishment and management of these "strategic" long-term alliances.

Several examples of early VBEs can be found in different parts of the world, including the Virtuelle Fabrik, in Switzerland; the IECOS, in Mexico; the CeBeNetwork, in Germany; the Helice network, in Spain; the NetworkA, in Finalnd; the Torino Wireless, in Italy; the network in Treviso region, in Italy; etc. (Camarinha-Matos, et al., 2009a). These cases are confined to specific geographical regions and usually use little support from collaborative ICT tools and are governed by a limited conceptual framework, constituting what can be called the 1st generation VBE, also known as industry clusters, or industry districts (Afsarmanesh and Camarinha-Matos, 2005; Camarinha-Matos and Afsarmanesh, 2005). When these strategic networks have a business-oriented nature, and a more intense use of advanced ICT tools to support collaboration, the term collaborative business community is also used (Traitler et al., 2011). Related to the previous concepts, but considering contexts where the geographical binds are not so relevant, there is the notion of business ecosystem (Rong et al., 2013), which can be extended, to get closer to the general notion of VBE.

A 2nd generation of VBEs, a new model and conceptual framework for VBEs, and creation of VOs within VBEs, was proposed in the ECOLEAD project. A solution with corresponding advanced support ICT infrastructures and tools was also achieved (Afsarmanesh et al., 2008a; Afsarmanesh et al., 2011). Later on, the concept of innovation ecosystem is introduced with similar characteristics of a VBE, but with a more open border (Rabelo et al., 2015).

As an example of the importance of the adopted models, some other works make attempts to tailor Enterprise Architecture Modeling (EAM) methodologies to the requirements of virtual organizations, as is the case of (Paszkiewicz and Picard, 2009). Also, (Polyantchikov et al., 2012) propose an Enterprise Architecture management approach for systems integration as a way to selecting partners for collaborative networks. For that purpose, the fundamental elements being considered are also the ones adopted in this work for the VBE and VO that are inherited from the ECOLEAD project.

2.1.2 Reference Model

Modelling complex systems, such as collaborative networks, requires a proper framework to capture their complexity. In this line, ARCON (A Reference model for Collaborative Networks) modelling framework, was developed in the context of the

ECOLEAD project (Camarinha-Matos and Afsarmanesh, 2008d), being inspired by the frameworks introduced in the literature related to enterprise and supply chain modelling, but focusing specifically on CNs. To cover relevant aspects of CNs, ARCON considers their complexity and wide variety of aspects and constituting elements, providing an approach to divide this complexity into three perspectives: life-cycle, environment characteristics, and model intent. The three modelling perspectives are illustrated in Figure 2.5:

(i) **Life-cycle perspective** related to the different stages and possible evolution along the CN life-cycle.

(ii) **Environment characteristics perspective** considering both the internal and external aspects of a CN, i.e. how to understand the network from inside (as in traditional systems modelling) and from outside (i.e. the interactions between the CN and its surrounding environment). This perspective is thus divided in two sub-spaces:

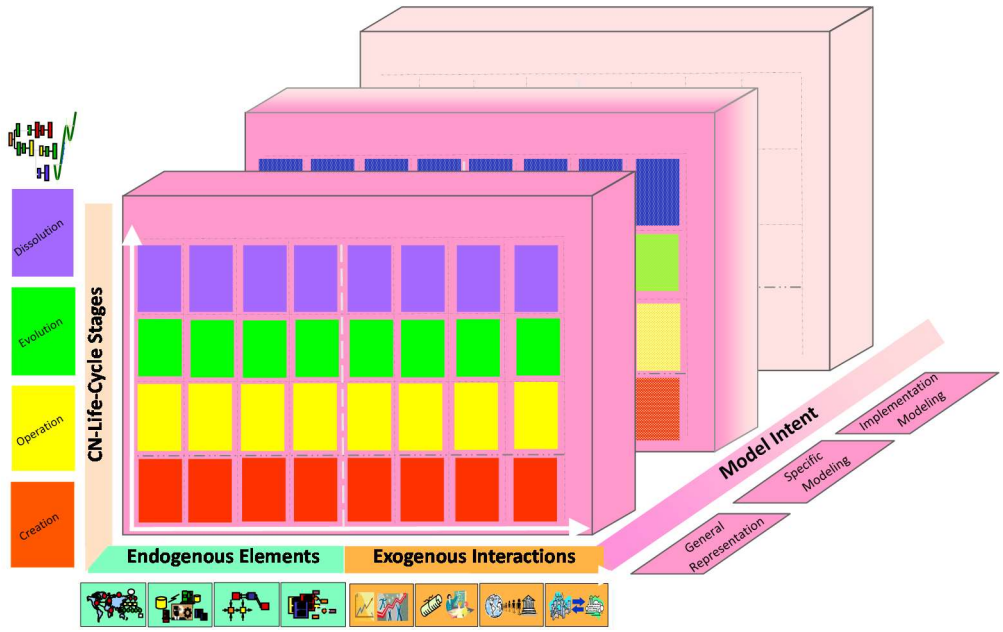

Figure 2.5. ARCON reference modelling framework
(Camarinha-Matos and Afsarmanesh, 2008b)

Endogenous Elements. This sub-space aims at providing an abstract representation of the CN characteristics *from inside*, namely the identification of a set of elements/properties that together can capture and represent CNs. For that, four dimensions are defined: (i) structural dimension, addressing the structure or composition of the constituting elements of the CN, namely its participants, their relationships, and the roles they perform; (ii) componential dimension, addressing the individual tangible and

intangible elements in the CN, such as different resources e.g. human elements, software and hardware resources, as well as information and knowledge; (iii) functional dimension, addressing the "base functions/operations" running and supported at the network and time-sequenced flows of executable operations (e.g. processes) related to the different phases of the CN life-cycle; and (iv) behavioral dimension, addressing the principles, policies, and governance rules that either drive or constrain the behavior of the CN and its members over time.

Exogenous Interactions. This sub-space aims at reaching an abstract representation of the CN as seen from the outside, that is, which characteristic properties the CN reveals in its interaction with its surrounding environment. In this case, four dimensions are also defined: (i) market dimension, related to both the interactions with "customers" and "competitors", such as the transactions and established commitments, marketing and branding, etc.; (ii) support dimension, related to support services provided by third party institutions such as insurance services, auditing, regulators, etc; (iii) societal dimension, related to the interactions between the CN and the society in general, with the aim of modeling the impact that CN has or potentially can have on the society; and (iv) constituency dimension, related to the interaction with the universe of potential new members of the CN. In this case, general issues like sustainability of the network, attraction factors, etc., are considered.

(iii) **Model intent perspective**. This perspective is related to the multiple intents for modelling CNs, considering three layers: (i) general representation including the most general concepts and related relationships, common to all CNs independently of the application domain; (ii) specific modeling including more detailed models focused on different classes of CNs; and (iii) implementation modelling representing models of concrete CNs.

Positioning a negotiation support environment for the creation of VOs in ARCON modeling framework, two perspectives can be considered: the CN life-cycle and environment characteristics, namely the endogenous elements. Regarding the life-cycle perspective, we need to consider the creation and evolution phases of a CN, where agreements among CN participants might be required. On the other hand, the endogenous elements of the environment characteristics, are considered since the VO creation negotiation process is an internal process for its participants. The main related elements are: *structural* to negotiate the constituting participants, their relationships, and corresponding roles; *componential* to negotiate the main competences and resources for the VO; *functional* to negotiate the VO plan in relation to its execution processes; and *behavioral* to negotiate the main governance principles for the VO.

2.1.3 Risks in Collaboration

Considering the environmental characteristics of collaboration, increased levels of globalization and customer demands, networks of organizations are more exposed to risks (Chen et al., 2013). Furthermore, while in a traditional enterprise setting the overall risk exposure may have a more static nature, even in the most dynamic business environment, in a virtual organization the risks themselves are highly dynamic, mainly because of the possible swapping of players within the network (Husdal, 2010). Therefore, in the VO creation process, VO associated risks and their prediction is one topic that has considerable importance and can influence the negotiation process. The success of these networks, among other challenges, requires healthy relationships among the involved stakeholders and the adoption of working methods that are considerably different from traditional subcontracting practices (Harland et al., 2003). Such changes naturally involve numerous uncertainties and risks, most of which are not fully identified or understood yet. In fact, while most literature on collaborative networks emphasizes the potential benefits of collaboration, only a few works have addressed the issue of the associated risks. Furthermore, risks are not static, and as collaborative networks evolve, so do the risks (Alawamleh and Popplewell, 2012).

Being risk an ambiguous concept, it is differently defined according to the specific application and the situational context (Jüttner et al., 2003). One of the most common meanings for risk is a threat or danger, which often implies the probability of a negative outcome. (Harland, et al., 2003) have done an exhaustive review of definitions and classifications of types of risk and defined risk (R) as the product of the probability (P) of a loss (loss) by the significance or impact (I) of the loss, related to an event n (n): Rn = P(loss)n x I(loss)n. Other authors claim that risk, *per se*, has neither a positive nor a negative value and is perhaps more related to uncertainty, where eventualities can be either beneficial or adverse (Husdal, 2010). Considering the VO life-cycle, there are of course some risks that traditional risk management does not deal with, in particular when considering the sharing of skills, costs and access to each other's markets. Also, risks may change from project to project or opportunity to opportunity. Therefore, new challenges on how to manage VO risks need to be faced.

Although not yet widely addressed, the issue of risks in collaborative networks has started to appear in literature. Some earlier works, such as (Norrman and Lindroth, 2004), addressed risks in a supply chain, classifying them as external and/or decision-driven risks, with different sources, namely organizational, network, and/or environmental. Other works focused on the identification of risk sources and risk categories. For instance, (You et al., 2006) consider the risks of loosing core competences,

misalignment of enterprises cultures, and knowledge spillover. More recent works, e.g. (Broser et al., 2010), focus on the information management aspects, considering that networks bring along additional risks regarding information security and privacy which may lead to compliance violations. An analysis of various risk factors during the stages of the life-cycle of a virtual enterprise is made by (Wang et al., 2011), that propose the use of a two-level fuzzy evaluation to analyze these risks. Fatemi in his PhD thesis (Fatemi, 2012), also addresses various types of risks, including the risk of no feasible coordination, the risk of fraud or in general untrustworthy partners, and the risk of non-profitability. In all cases, when performing a risk analysis or forecasting, it is essential to consider and respond to some questions, such as (Klibi and Martel, 2012): *What can go wrong?; What are the consequences?; and What is the likelihood of that happening?*. Regarding these questions, some concepts and approaches can be borrowed from catastrophe analysis (Banks, 2005; Haimes, 2005; Patel et al., 2005) and Supply Chain Networks vulnerability analysis (Kleindorfer and Saad, 2005; Sheffi, 2005; Wagner and Bode, 2008).

Considering the vast universe of risks and their contextualization, a more comprehensive list is considered in (Alawamleh and Popplewell, 2012), which identify 13 sources of risks, namely: lack of top management commitment, inadequate collaboration agreements, ontology differences, risk from heterogeneity, structure and design risks, loss of communication, culture differences, difficulties arising from geographic distribution, lack of trust, insufficient information sharing, knowledge about risks, and bidding for several virtual organizations at the same time. Several of these risks are related to partners' selection and the initial establishment of the network. Therefore, if some risks are forecasted and mitigated in the creation phase of VOs, supported by a negotiation environment, it is likely that we can avoid certain risks during collaboration.

2.2 Negotiating and Contracting

Negotiation is an iterative communication and decision-making process between two or more autonomous entities who seek a consensus decision as they cannot apply unilateral actions to achieve their objectives (Ströbel and Weinhardt, 2003; Turel and Yuan, 2007; Alfonso et al., 2014).

As negotiation processes involve a transversal, multi- and inter-disciplinary approach, it is necessary to move towards a holistic view of the problem, making use of multiple methodologies and paying attention to the practical details (Gimpel, 2008). According to previous research, a negotiation process can rely on several mechanisms

such as auctions, game theory, intelligent agent mechanisms (Rocha and Oliveira, 1999; Ness and Haugland, 2005; Vignola et al., 2012). Nonetheless, such process is often conducted by human actors, which in the last instance are the ones responsible for approval (Nicola et al., 2012) and decision-making. Although some works try to implement some automation into the negotiation process (Jennings et al., 2000; Bartolini et al., 2005; Mukhopadhyay et al., 2012), this continues to be a rather difficult issue. For example, the automation of negotiation using software agents is well suited when contextualized in well-structured areas (Weigand et al., 2003; Mancini, 2009; Miller, 2014) but still limited in other cases.

One of the common criteria to classify a negotiation (Buttner, 2006) is the number of negotiating partners: bilateral, one-sided multilateral and double-sided multilateral negotiations, where bilateral negotiations are restricted to two negotiation partners (typically one buyer and one seller), one-sided multilateral negotiations are deemed to be the standard form of auctions and are either characterized by one seller and many buyers or vice versa, and finally double-sided multilateral negotiations are characterized by many buyers and many sellers. All these cases can happen in the scope of VO creation.

The result of a negotiation process is typically a contract or agreement explicitly representing the consensus reached. Usually contracts or agreements are used to regulate the exchange of values (e.g. goods, knowledge), and mainly their provisions are for protection of parties in case that something does not go according to what was planned, and to describe what was agreed in the case that any party forgets it.

A formal approach to describe agreements or contract models is through deontic logic (Meyer and Wieringa, 1993), through which obligations, permissions, and forbiddances for a specific business process, can be specified. Although this work facilitates the formal structure of documents (Quirchmayr et al., 2002; Xu, 2004), results are far from practical applicability since the approach reflects an extremely ideal process. From a more pragmatic perspective various efforts have been put in the representation of contracts in XML (Carter et al., 2001; Angelov and Grefen, 2002). Another representation is proposed by (Grefen and Angelov, 2002) that divide the contract content into three general parts: (i) the first part describes the participating parties and mediators; (ii) the second part provides the rights and obligations of the parties; and (iii) the third part gives the required definitions for the contract enactment. These definitions can range from the business context of the contract to different terms and formulae used in the contract. The definitions aim at establishing an identical understanding about the contract among all participating parties. Accordingly, in the CN context, contract models can be characterized by templates that enable parties to specify contracts or agreements

(Vignola, et al., 2012), which can be monitored / enforced by a computer-supported contract framework.

A contract framework comprehends a computer-supported environment in which a contract for a certain collaboration opportunity is created / specified, executed and monitored (Xu, 2003, 2004; Xu and Vrieze, 2007). A relevant work in this area has been developed by Strecker et al. (2006), including a prototype that contributes to the bilateral negotiation effectiveness, with a central emphasis on two key components: the negotiation process model, and the negotiation protocol. Here the main scope comprises the phases of pre-negotiation analysis, conducting negotiation, and post-settlement analysis. Although the authors claim that the used methodology has been supported by negotiation experts, they also admit that usually unstructured negotiations via email, phone or face-to-face are still preferred. Another relevant work is presented in (Barata and Camarinha-Matos, 2003) when defining a contract life-cycle to address coalitions of collaborating machines in an agile shop floor environment. In this case, three main phases are described: formation, performance (which is the execution phase of the contract) and termination. Also in this work, it is explicit that for a contract or agreement to become valid and robust, the formation phase of the contract is vital.

Another line of work can be found in (Picard, 2004) proposing a model for electronic non-monolithic collaborative document edition, the document-group-message model. This model is mainly focused upon the production of a contract document following a collaborative edition basis, with versioning control. It specifies the negotiation group dynamics model, as well as the messages exchange model.

Related to this topic, are the available negotiation software tools, that according to (Kersten and Lai, 2007) can be classified according to: (i) the typology of participation, making the distinction between software-as-tool and software-as-participant; (ii) type of negotiation support, if it provides a facilitation or mediation in the negotiation process; and (iii) the type of supported negotiation activities (pre-negotiation, negotiation, and post-negotiation).

One interesting work is the case of the V-Mart, an open market model and enabling framework, for automated service negotiation and contracting in network virtualization environments based on auctions (Zaheer et al., 2010).

When the main aim is to produce a context-independent solution, automation is a main obstacle of the negotiation process (Angelov and Grefen, 2002). Thus, as mentioned, only partial and very specific solutions and prototypes for negotiation are available, as it is for example the case of the eLegal project (Carter, et al., 2001) where the main goal was to develop solutions for legal issues related to VOs in the area of civil

construction. Nevertheless, this framework would be prepared specifically for each project.

In most business settings, to increase the likelihood of trust in dialogs and exchange of information, negotiation will still need to be performed by humans in the foreseeable future (Goldstein, 2012), since decisions are often based on experience and intuition rather than rationality (Shyur and Shih, 2015). In these cases, negotiation support systems may have an important role to play (Kersten and Lo, 2003; Madani et al., 2014), being therefore the typology of participation seen as *software-as-tool*.

In the services provision domain, another solution for negotiation based on the Service Level Agreements negotiation architecture is proposed in (Di Nitto et al., 2007). Also in this case, the approach continues to be very specific to customer-provider solutions and does not completely cover collaboration aspects. Similar to this example, when referring to contracts and negotiations, various proposals are related to customer-provider relationships, as the example described in (Gimpel, 2008) with the aim of: (i) designing and constructing places where goods and services can be bought and sold; and (ii) providing services associated with buying and selling. For that, the authors make use of legal frameworks, economic mechanisms, management science models, and information and communication technologies.

Complementarily and similarly to institutions in human societies, electronic institutions can provide a structured framework for agents to regulate their interactions (Campos et al., 2009). Electronic Institutions are mainly frameworks that facilitate, through a communication network, automatic transactions between parties, according to sets of explicit institutional norms and rules. The work described in (Esteva et al., 2004) presents a set of tools that support the specification, analysis and performance of institutions, as well as the implementation of agents. Thereby, the electronic institutions ensure the trust and confidence needed in any electronic transaction (Cardoso and Oliveira, 2008; Bonatti et al., 2014). They can also be seen as institutional normative environments (Cardoso, 2010) that besides providing a set of regulations under which agents' collective work is made possible, also provide: (i) monitoring, to check whether agents are willing to follow the norms they commit to; and (ii) enforcement, to employ correction measures as a means of coercing agents to comply (Fornara et al., 2013). In this line, (Cardoso and Oliveira, 2008) describe an approach towards the development of an electronic institution providing an enforceable normative environment. Within this environment, institutional services are provided and assist agents in forming cooperative structures whose commitments are made explicit through contracts. A good potential can be found in such type of work since it addresses the application into the

B2B field, namely regarding the formation of virtual organizations (Cardoso and Oliveira, 2008; Cardoso and Oliveira, 2009).

According to (Grefen and Angelov, 2002), in order to enable a fast contracting process, an electronic representation of contracts is required, as standard paper-based contracting is often slow and requires involvement of human actors in all negotiation and contracting phases. Thus, computer-assisted negotiation and e-contracting is expected to provide a faster and cheaper solution than standard contracting. On a different perspective (García-Camino et al., 2006) propose some means to specify and control the normative dynamics of societies of software agents. They introduce a language with which one can explicitly manage the normative positions of agents. This language is conceived as a machine-readable language to facilitate norm-oriented programming and to find higher-level normative languages. Furthermore, (Aldewereld et al., 2007) propose an extension to electronic institutions to allow a flexible enforcement of norms to help overcoming the difficulties of translating abstract norms when implementing electronic institutions.

Focusing on a consortium agreement, the aim is to establish the necessary clauses to regulate the consortium behavior, governing rules and principles during the VO operation phase. Therefore, special attention should be put into e-contracting forms as they can capture and describe the rights and duties of all VO partners (Rocha et al., 2005; Hernández et al., 2014), as well as the specification of penalties to apply to those that do not satisfy the agreement (Miles et al., 2008).

Furthermore, legal and contractual issues associated to each contract/agreement concentrated on the ICT perspective can be found in (Shelbourn et al., 2005; Oren et al., 2009). From the legal point of view, the European efforts to deal with new technologies used for commercial communication and contracting led to the directives 97/7/EC, 2000/31/EC and 93/13/EEC. Internationally, requirements for e-contracting are given by the OECD Recommendation concerning Guidelines for Consumer Protection in the context of Electronic Commerce (OCDE, 1999) and UN convention on electronic contracting (UNCITRAL, 2005). Also, in order to certify the consent to the contracting terms, in e-contracting, the notion of digital signature becomes relevant.

Digital Signatures are methods to authenticate digital information using cryptographic techniques. They can be used to authenticate the identity of the sender of a message or the signer of a document, but also to certify that the original document content has not been changed and that the document was sent from the genuine party. This means that digital signatures can also be used during the exchange of non-legally binding documents between parties. As a result, legally binding digital signatures have

to be differentiated from non-legally binding digital signatures. A possible solution to this problem is provided in the ebXML standard (Waldt and Drummond, 2004). These mechanisms also involve a notion of non repudiation since the signatory cannot, at a later time, repudiate the signature. Several cryptography-based algorithms exist for implementation of digital signatures, such as DSA, RSA, blind RSA, Schnorr and ECDSA (David and Jacques, 2000; Boneh, 2011). The directive 1999/93/EC of the European Parliament and of the Council on a Community framework for electronic signatures provides clarification regarding the use of digital signatures.

Hence, computer-assisted negotiation and e-contracting are expected to provide more improved solutions than traditional contracting for geographically distributed consortia formation because the process can be faster and cheaper. Hence, several significant characteristics of the e-contracting process can be found in (Angelov, 2006), namely the structured content that must be presented in a formal way, preventing misinterpretations or contract violations. Furthermore, an electronic contract can have both a machine-readable and a human readable representation, being the existence of a human readable representation of the contract required when its creation and management involves the participation of human beings.

Also, one important aspect of electronic negotiations, particularly in multi-cultural contexts, is the employed vocabulary. One interesting work developed by (Ströbel and Weinhardt, 2003) proposes a taxonomy which allows the characterization and comparison of a broad variety of electronic negotiation mechanisms and systems, ranging from auctions to bilateral bargaining tables. Their focus is however on negotiation processes in electronic markets for the exchange of goods, services, and knowledge based on bargaining, bidding, or dispute resolution, and do not take into account other forms of negotiation such as group decision-making or voting. Therefore, in this case, the taxonomy, by itself, cannot be directly applied to collaborative networks, but it can certainly be adapted. In (Pereira and Soares, 2008) a method to support the collaborative construction of semantics in an inter-organizational context is proposed. There, the authors analyze the main problems and gaps in current ontology development methods regarding collaboration and negotiation in early development phases. However, the use of a common ontology in certain domains, although beneficial, can be complex (Jardim-Goncalves et al., 2014). A solution to improve common knowledge among business domain experts is proposed in (Sarraipa et al., 2010) through the MENTOR methodology to support the development of a common reference ontology for a group of organizations sharing the same business domain, while keeping their internal ontology and semantics unchanged. To model a network contract, (Villa

and Bruno, 2013) propose an ontology model to overcome legal aspects of contracting amongst different European countries.

Advances in the negotiation domain are also a result of the usage of information systems and communication media to support negotiation processes and decisions. For example, Negotiation Support Systems (NSS) provide varying levels of structured communications and decision support, and offer both dispute resolution mechanisms (i.e. dealing with infringements of existing contracts) as well as contract formation services (i.e., creating new agreements) (Turel and Yuan, 2007; Shyur and Shih, 2015). For instance, in the CrossFlow and E-ADOME projects, the established contracts describe the agreed activities and transitions as workflow interfaces based on WfMC's WPDL (Workflow Process Definition Language) (Grefen et al., 2000; Chiu et al., 2001). In addition, (Oliva et al., 2010) propose the Supporting Artifacts for Negotiation with Argumentation (SANA) framework that assists the negotiation participants to engage in negotiation dialogs, generating and exchanging proposed deals in order to reach mutually-acceptable proposals. Nonetheless, this proposal assumes the existence of a mediator that regulates the entire negotiation process. In all cases, to structure the negotiation arguments, it is essential to have a common ground for the multiple participants, so that the negotiation process can be effective (Hu et al., 2010).

The negotiation process includes several interactions that are based on the exchange of some arguments and opinions in the form of dialogues (Moschoyiannis et al., 2009). The dialogues that take place can include some form of argumentation in favor or against certain statements (Caminada and Amgoud, 2007). Depending on the context, the arguments used can be constructed from a knowledge base in an argumentative system (Prakken, 2010), or from a rule-based system (Caminada and Amgoud, 2007). A proposal from (Neto et al., 2013) includes an argumentation model based on past contractual data and aiming at enriching electronic contracting processes.

Typically protocols for negotiation based on argumentation can be found in agent systems where agents have a certain level of intelligence and at some point have to make their options and create some arguments (Aknine et al., 2004; Wang et al., 2014). In these cases, although there are already some agent communication languages such as ACL, KQML, etc., that try to cope with some of the requirements for negotiation (Beer et al., 1999), there are still open issues, namely the existence of some limitations regarding multilateral negotiation when compared to one-to-one bilateral negotiations (Wang, et al., 2014).

In the CNs context, with the aim of including a negotiation support environment for the creation of VOs, its specification can certainly borrow concepts and models from the topics mentioned in this section (contract models, contract frameworks, electronic institutions, negotiation protocols, etc.). The assumption is to pursue a context-independent environment, not fully automated, to assist the human user. The design and specification of such environment is described in chapter 4.

2.3 Business Services

To maintain and/or increase market competiveness, one tendency for manufacturers is to associate business services to the products they offer. As such, one earlier definition by (Hill, 1977) states that: "*A (business) service is a change in the condition of a person, or a good belonging to some economic entity, brought about as the result of the activity of some other economic entity, with the approval of the first person or economic entity*". Also according to Hill, business services and goods (or physical products) are of different ontological categories: while goods are both transactable and transferable, services are transactable, but not transferable.

In spite of some efforts, as represented by the *Services Science movement* (Chesbrough and Spohrer, 2006; Bitner and Brown, 2008), the notion of service remains ambiguous. Two main literature streams – management, and computer science – among others, have proposed a number of definitions that often represent a partial perspective of the concept.

The ICT developments tend to consider services as some form of "black boxes" that perform some action, being more focused on data, control flow, and interoperability aspects. Other areas consider services from a business perspective, where services contribute with an added value that is delivered to a customer (Schuh et al., 2011) and its conditions of delivery. Under this perspective, issues such as quality of service (QoS), service level agreement (SLA), terms and conditions, period of availability, interactions with customer, etc., become the focus of attention. Recent works have tried to bridge the gap between these two notions of service (Ferrario and Guarino, 2009; Cardoso and Camarinha-Matos, 2011). Similarly, an ongoing initiative to establish a *Unified Service Description Language* (USDL) (Oberle et al., 2013) makes an attempt to merge various perspectives of service. Although clearly in line with the "ICT school", namely regarding the developments in Service-Oriented Architectures, Web Services and Semantic Web Services, USDL tries to also embed aspects of business services, service networks and service provision systems (Tohidi, 2011). However, it makes sense to separate two

concepts: business service, and software or technical service. Although they can be interrelated, they correspond to different views or perspectives that need to be clarified. A business service typically involves some flows of activities and interactions with the customer. Here, the terms of business service and business process appear (confusingly) intermixed, although they also correspond to different concepts.

Another definition of business service (Ferrario and Guarino, 2009) puts the focus on the notions of availability and delivery of the service: "*A service is present at a time T and location L if, at time T, an agent is explicitly committed to guarantee the execution of some type of action at location L, on the occurrence of a certain triggering event, in the interest of another agent and upon prior agreement, in a certain way*". This definition brings about a number of interesting aspects:

- The notion of commitment through which an entity guarantees the execution of some kind of action(s) in the interest of the customer. This notion comes in line with another definition by (O'Sullivan, 2006): "*A service instance is essentially a promise by one party (the provider) to perform a function on behalf of another party at some time and place and through some channel*";
- Commitment and availability are different notions. For instance, in the case of malfunctioning periods (of the service provision system) or working pauses, the commitment still holds but the service is not available (temporarily). Specific constraints regarding availability can be defined in the agreement (service level agreement) or contract;
- The commitment by an agent to guarantee a service does not necessarily imply that the service is performed by this agent; it can be delegated on other entities, although the responsibility toward the customer remains with the agent that made the "promise";
- A service delivery implies a delivery location where the actions take place or the added value is provided; and
- The actual delivery of the service, i.e. the execution of the associated action(s), is initiated by a triggering event. For instance, in the case of a reactive maintenance service, the triggering event can be the detection of a malfunctioning alarm. In case of a preventive maintenance service, the triggering event can be the scheduled time for the periodic maintenance.

Furthermore, the notion of business service can be considered as an abstract construct that encapsulates the external or customer's view, specifying what (value) and under what conditions it would be delivered, while internally some business processes can materialize the services. In other words, the business processes (and associated triggering events) represent how the business service is performed (Ilayperuma and

Zdravkovic, 2015). The performance of the actions involved in the business service delivery can be done automatically or manually. The automatic solutions can be materialized through the invocation of some software services, while manual services are human-executed activities. These notions are represented in Figure 2.6.

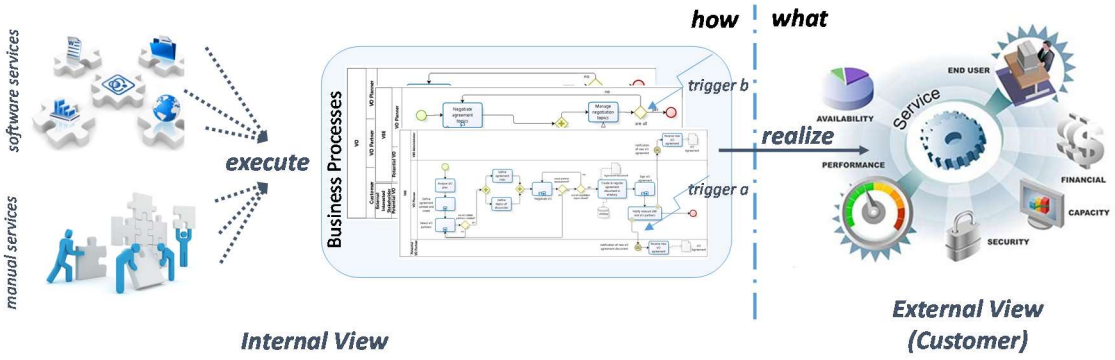

Figure 2.6. Views of business service, adapted from (Camarinha-Matos, et al., 2013d)

Service delivery is subject to a number of conditions agreed between the provider and the customer that are typically formalized in a contract / agreement, and govern the responsibilities of all involved parties. Also, implicit in the notion of service, there is the notion of ***service provider***, that is, the entity that delivers the service to the customer.

Past developments in this area have been characterized by some fragmentation, where the focus has been predominately put on the development of isolated services, each one typically provided by a single organization, and often showing an excessive techno-centric flavor. A current trend is to move from fragmented services to progressively more integrated services (Antunes and Moreira, 2011; Camarinha-Matos, et al., 2013c), which are likely to be provided by multiple stakeholders through well-elaborated collaboration mechanisms (Päivi and Antikainen, 2015). Therefore, a composite business service is a collection of related and integrated business services that provide a specific business solution. In this context, customers more and more demand for integrated business services (which are composed of simpler / atomic services) and that provide a specific business solution. Provision of such services tend to involve the collaboration of multiple stakeholders, organized in collaborative networks (Camarinha-Matos et al., 2014b). In this case, besides the stakeholders directly involved in the provision of the simpler (or atomic) services, a stakeholder with a new role appears, the ***service integrator***, which coordinates the other stakeholders and possibly offers a unique contact point to the customer. The customer would typically establish a single contract with the service integrator and not separate contracts with the other

providers (Camarinha-Matos, et al., 2013d). For the provision of the composite service, the group of involved entities together form a virtual organization. This organizational structure and the role of the business service integrator open new collaboration opportunities for SMEs.

Furthermore, to achieve innovative business services, a virtual organization might be created with the aim of designing a new service with multiple stakeholders knowledge. Here, the design-science paradigm and related knowledge appears to extend the boundaries of human and organizational capabilities by creating new and innovative artifacts (Hevner et al., 2004). During the last years, the importance of design and the value of design thinking as a tool for innovation have been recognized (Gruber et al., 2015).

Service design is an interdisciplinary area that emerged as a contribution to a changing context from the growing economy of the services sector and the traditional culture of design (Sangiorgi, 2009). Service design integrates relevant stakeholders in the design of services through some methodological approach (Mager and Sung, 2011). It aims at designing user-oriented business services making them useful, effective and different from existing ones, potentiating co-creation between the different users of a business service, and the providers (Sandberg, 2012). Services engineering is another existing term for the development of new services adapted to customers' requirements (Freitag et al., 2015), although typically associated to software services.

Numerous methods and tools have been emerging for service design (Wild, 2009), but most of them are just manual methods to organize a collaborative process. Some methods are supported by software tools and can be found in (Tassi, 2009) and (Ojasalo and Ojasalo, 2015). Nevertheless, no integrated environment is available, neither any integration between service design and service delivery environments is available. This leaves room for innovations that can be beneficial not only for providers and customers, but also for society in general (Reim et al., 2015). Some authors also defend that service innovation must always rely on actor-centric context, and the generated value a result of co-creation (Ojasalo and Ojasalo, 2015).

In this context, one interesting approach is the design and development of an environment that potentiates co-creation between different users of a business service and their providers.

2.4 Brief Summary

This chapter addressed a literature review on topics related to this thesis research work. The topic of collaborative networks, with special relevance for the creation of virtual organizations and their breeding environments, supports this thesis work on the development of a negotiation environment that increases agility in the creation of VOs. Considering the different approaches for VO creation, namely dealing with partners selection and negotiation, the level of autonomy may vary according to the different problem domains. Positioning a negotiation support environment for VO creation in the ARCON modeling framework, two of its perspectives can be considered: the CN life-cycle, considering the creation and evolution phases of a CN; and environment characteristics, namely the endogenous elements since the VO creation negotiation process is an internal process for its participants.

When relating the described topics with the proposed research work, it is noticeable that deeper research work is required in various fields specifically in what concerns mechanisms and systems to support communication, communities of organizations, negotiation protocols, etc. Despite several works have already addressed some of these items, due to the constant market evolution and technology advances, further research is mandatory because of the new requirements that are constantly challenging the current processes. Some of these challenges are related to communication channels, collaboration forms, negotiation protocols, etc. Considering some contracting frameworks, where the main trend is to automate the contract or agreement negotiation process, in the scope of CNs human intervention is essential in most of the cases. Another aspect is the fact that there is no reference model for the negotiation process that should be applied in a generic case. Therefore, an interesting research line is to derive a contract framework to cover the VO creation process. More specifically, if the main aim is to explore how an electronic negotiation support environment can increase agility in the process of creating successful dynamic VOs, it has to consider a complete collaborative background, where automation is not the focus and information for the agreement establishment is sometimes not totally clear. In this case it is also fundamental that a negotiation protocol is defined so that the agreement can be achieved.

3

Virtual Organization Creation

The concept of virtual organization appears particularly well-suited to cope with very dynamic and turbulent market circumstances. The underlying condition is the possibility of rapidly forming a consortium triggered by a collaboration opportunity and specially tailored to the requirements of that opportunity. Implicit in this idea is a notion of agility, allowing rapid adaptation to a changing environment. In order to make this possible, a VO creation process is designed in the context of a virtual organization breeding environment.

A virtual organization is a goal-oriented network based on an association of individuals and/or organizations that join their competences to rapidly and strategically respond to a collaboration opportunity. The duration of a VO can be variable according to the different requirements that lead the VO creation. The adopted definition of virtual organization (VO) in this work is therefore the following:

"A Virtual Organization (VO) is a temporary alliance of organizations that come together to share skills or core competences and resources in order to better respond to collaboration opportunities and produce value-added services and products, and whose cooperation is supported by computer networks." (Camarinha-Matos, et al., 2005a)

To respond to a collaboration opportunity, the VO creation process comprises the formation of a consortium with adequate competences, and the planning and scheduling of the work order. Therefore, it is important to consider the VO creation context. It is also

important to consider a negotiation mechanism that supports the potential consortium partners in achieving agreements during the VO creation process. These agreements will form the basis for the governing principles of the VO during its operation phase (Camarinha-Matos and Afsarmanesh, 2007; Picard and Rabelo, 2010; Stelmach et al., 2011).

As such, this chapter includes a section relative to virtual organizations recruitment spaces, with particular focus on the virtual organization breeding environment and its management system. The VO creation process is then described, also identifying the main stakeholders involved and their dependencies. The core business processes related to VO creation are detailed. Considering all the above, a conceptual architecture for a VO creation support system is then proposed.

Complementarily, and to enhance the VO creation process, an electronic notary and registry system is proposed to help guaranteeing the validity and authenticity of the agreement resulting from the VO creation.

3.1 VO Recruitment Spaces

The effectiveness of the virtual organization creation process is a critical element in dynamic collaborative networks. Early works on VO creation implicitly assumed that partners could be quickly identified and selected from the open universe of existing enterprises / organizations, and then engaged into a collaboration network. However, this identification and selection can be rather complicated and time consuming due to several obstacles that can negatively affect the level of readiness of organizations to participate in a collaboration process. Some of these issues include: how to find the most suitable partners; how to deal with lack of standardization in profiles; how to establish common infrastructure for collaboration; how to overcome the lack of existing trust among organizations; etc. (Camarinha-Matos and Afsarmanesh, 2003; Afsarmanesh and Camarinha-Matos, 2005; Camarinha-Matos, et al., 2005b; Durugbo and Riedel, 2013).

Thus, if the window of opportunity to respond to a collaboration opportunity is short, in order to support the rapid creation of a VO it is necessary that enough information is available about potential partners and that they are ready and prepared to participate in such collaboration. This typically involves the need to have a common interoperable infrastructure, common operating rules, defined cooperation agreements, and a base trust level among the participating organizations. Therefore, the adopted approach in this work considers that VOs are mostly created in the context of VO Breeding Environments (VBEs) (Camarinha-Matos and Afsarmanesh, 2003; Camarinha-

Matos, et al., 2005c), which provide a common ground for collaboration and thus support the required agility. In other words, a VBE is the primary recruitment space for the VO.

3.1.1 VBE Management

A virtual organization breeding environment is a strategic collaborative network that is based on an alliance of organizations adhering to a base long term cooperation agreement, and that have adopted common operating principles and infrastructures with the common aim of being more prepared to tackle collaboration opportunities. Early examples of such alliances, namely industrial clusters, were based on companies located in some region and focused on a specific business domain. If on one hand geographical closeness can offer several advantages for collaboration, such as having members with a common local culture and knowing each other, which facilitates creation of trust, and having a "sense of community", such closeness also brings some limitations in terms of access to new market opportunities and acquisition of new competences. Therefore, one trend in VBEs is to enable collaboration among a group of geographical dispersed organizations, resorting to effective communication infrastructures.

This work follows the VBE definition developed in the ECOLEAD project, which remains suitable in the actual market conditions and requirements:

"Virtual Organization Breeding Environment (VBE) is an association of organizations and related supporting institutions, adhering to a base long term cooperation agreement, and adopting common operating principles and infrastructures, with the main goal of increasing both their chances and preparedness towards collaboration in potential Virtual Organizations" (Afsarmanesh, et al., 2008b; Msanjila and Afsarmanesh, 2008b).

Therefore, a VBE provides some commonality and support for interactions among its members by offering:

- A base ICT infrastructure (for collaboration), establishing a common collaboration environment, thus contributing to reduce the cost/time of finding suitable partners for new VOs;
- Cooperative business rules and common metrics to assess members' and their performance, establishing the base trust for organizations to collaborate in VOs;

— Methods for recruiting new members and help them getting prepared for collaboration;
— A base ontology for the sector targeted by the VBE, reducing misinterpretations that can result, for example, from cultural differences; and
— A set of services to assist in the VO creation process, reaching agreements, and contract negotiation for establishment of VOs.

Moreover, a VBE facilitates the collection and maintenance of members profile data, thus enabling the use of more sophisticated selection criteria, including aspects such as trust and historical collaboration performance. This would not be possible in an "open universe" of organizations, since there is no practical means for rapidly collecting the necessary data and getting members prepared to quickly start working together.

As such, the establishment of a VBE requires a proper management system that should provide services to manage members' profiles and VBE's competences, to support performance management, and to facilitate trust building among VBE members. The main strategic goal of a VBE is to increase preparedness of each member of the alliance towards rapid configuration of temporary alliances in response to market opportunities.

3.1.1.1 Actors and their Dependencies in VBE Management

To properly model the core functionalities of a VBE management system, the main involved actors with the corresponding roles are identified and summarized in Table 3.1 (Afsarmanesh, et al., 2008b).

Resulting from the interaction with end-users companies that participated in the ECOLEAD and GloNet projects, dependencies among the mentioned roles were identified. These dependencies are illustrated in the next figures using the i* framework (see Annex A for more details).

Figure 3.1 shows the strategic dependency model for the VBE management that includes relevant dependencies (ellipse) among roles (circles), comprising dependencies to join and leave the VBE; potential customers' dependencies to consult a VBE portfolio of products and attain new products; and VBE members' dependencies from VBE to access other VBE members profiles. Also, soft goals (ambiguous goals) are included, such as *facilitate trust building*. Resources (rectangle) may also be exchanged (physical or informational objects that are available) as is the case of VBE Products Portfolio.

Table 3.1. Main roles in VBE management

Role	*Description*
VBE Administrator	The VBE Administrator role can be performed by an individual or an organization responsible for: VBE operation and evolution; promotion of cooperation and/or collaboration among the VBE members; daily management of the VBE general processes and ensuring proper management of VBE members' profiles and competences. This role can also be named VBE Coach.
VBE Member	The VBE Member represents any organization that is member of the VBE. Each VBE Member individually has its own capacities, skills and resources that characterize its competences. The members may range from enterprises to other organizations, such as consulting/research institutes, sector-associations, governmental support organizations, financial institutions, etc., and even free-lancer individual workers that represent a kind of one-person small organization.
Potential VBE Member	Potential VBE Member is an organization that aims to become a member of a particular VBE.
Potential Customer	Potential Customer is an individual or organization that is interested in making/acquiring a new product or service order.
Customer	Customer is an individual or organization that is currently benefiting from a product or service provided by the VBE.

Figure 3.2 clarifies the internal dependencies of the VBE administrator to accomplish its dependencies, main goals and tasks, such as *accept new member*, *manage member profile / competences*, etc.

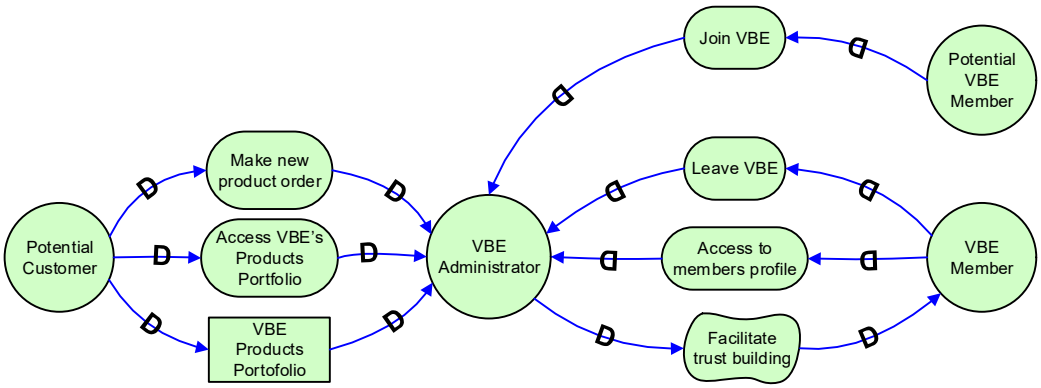

Figure 3.1. Strategic dependency model related to VBE management

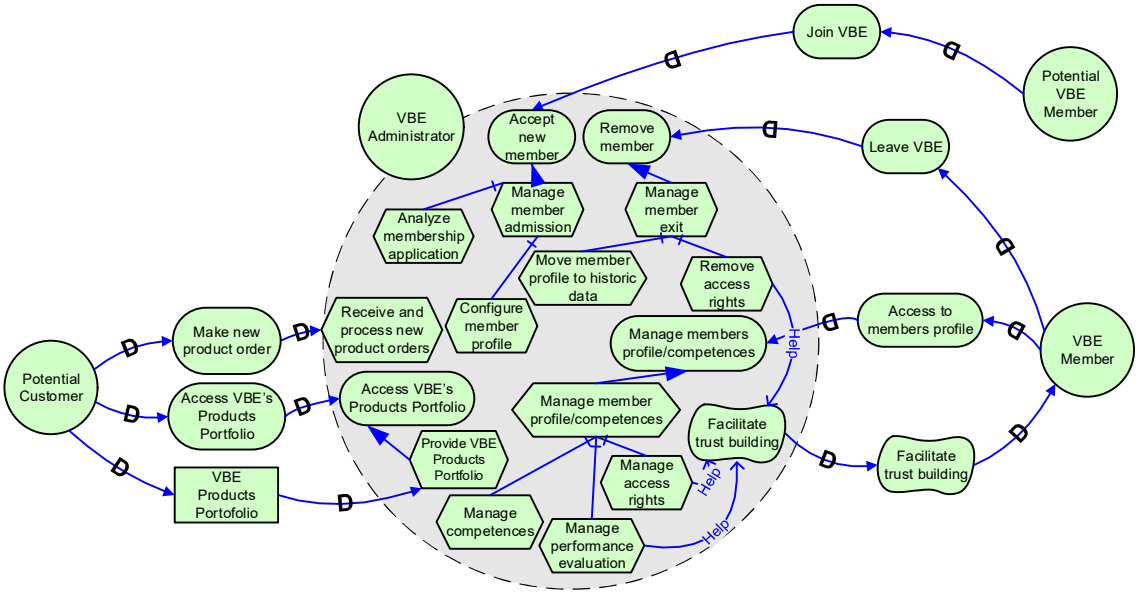

Figure 3.2. Strategic rational model related to VBE management (partial view – VBE Administrator)

Figure 3.3 clarifies the internal dependencies of the VBE member role to accomplish its dependencies, main goals and tasks, such as *access to members profile*, *leave VBE*, etc.

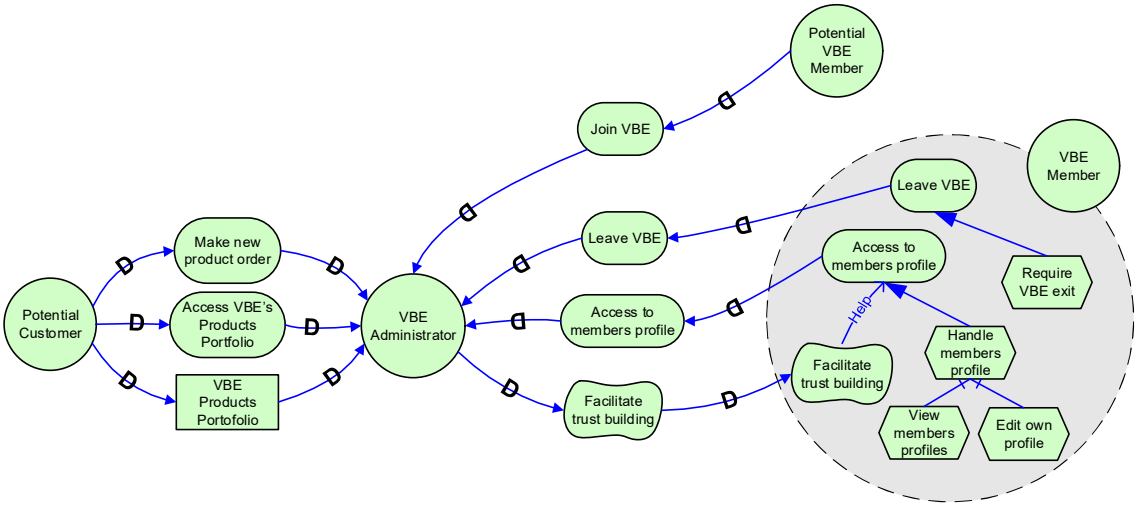

Figure 3.3. Strategic rational model related to VBE management (partial view – VBE Member)

3.1.1.2 VBE Management Business Processes

Depending on the geographical area or even on the market niche in which the VBE operates, different business processes might be necessary. From the research projects in which the author of this thesis participated, but specially from GloNet (Camarinha-

Matos et al., 2013b), resulted that a VBE management system should cover a number of common business processes, such as: *Member admission; Member withdrawal; Management of members profiles; Accessing member's profile; Management of VBE performance system;* and *Consulting VBE's products/services portfolio*.

In more details:

Member Admission: this process initiates with the reception of an application from a potential VBE member, which is then evaluated and approved or rejected. In case the application is approved a set of information elements is required in order to build the member's profile.

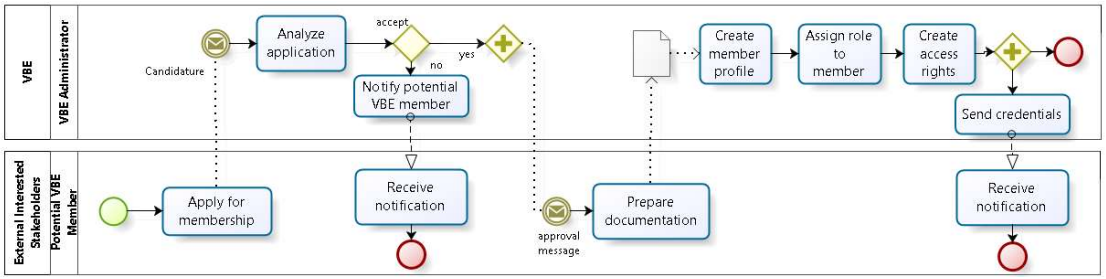

Figure 3.4. BPMN diagram of the VBE member admission process

Member Withdrawal: this process can be initiated either by a request from a VBE member to leave the VBE, or by an expel action (the diagram below illustrates the two cases). Depending on the VBE governing principles, the withdrawal may imply keeping the history data of the member that left and/or announcing the event to other VBE members.

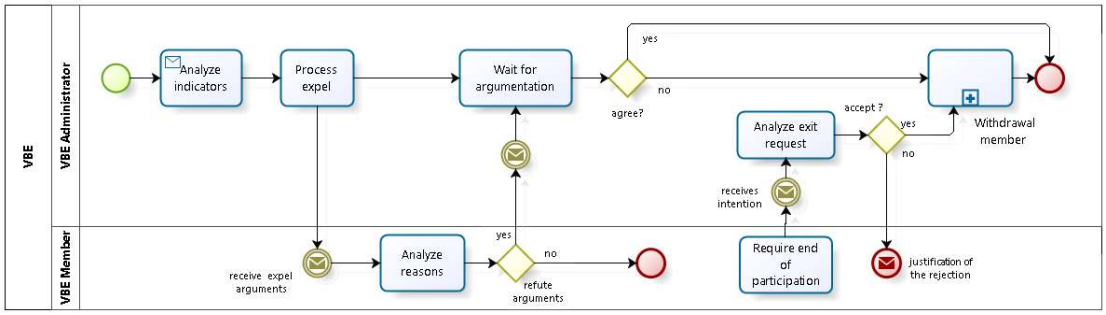

Figure 3.5. BPMN diagram of the member withdrawal process

Management of Members Profiles: this process comprises the activities of updating information about members' competences and performance, and searching information about VBE members.

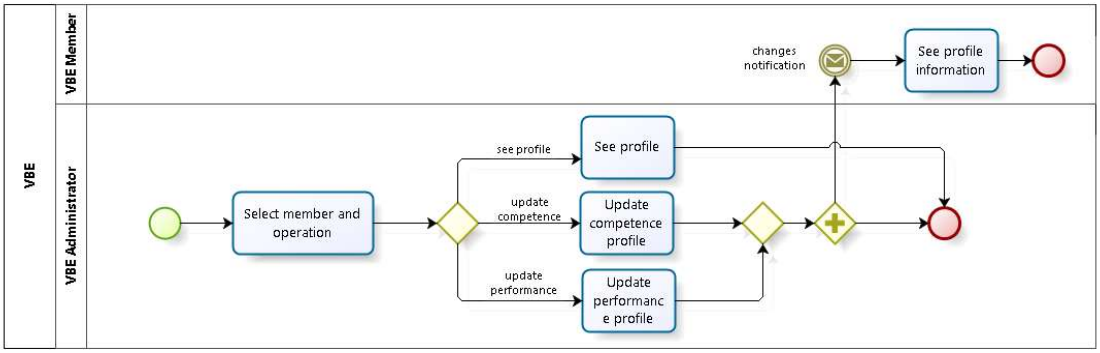

Figure 3.6. BPMN diagram of the management of VBE members' profiles process

Accessing Member's Profile: this process comprises the activities performed by a VBE Member to access another VBE member's profile, or its own profile. In the last case, the VBE member can see more detailed information and/or change some data.

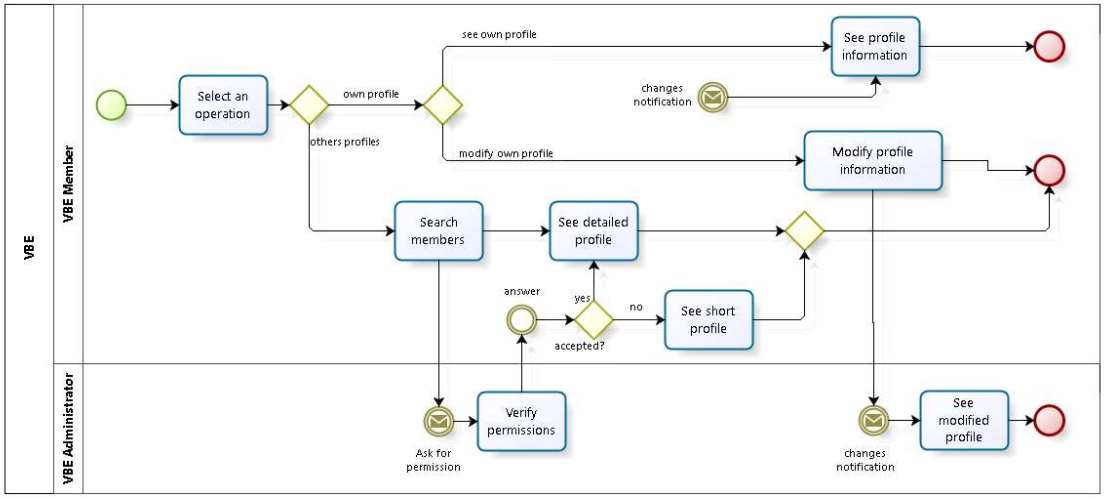

Figure 3.7. BPMN diagram of the accessing members' profile process

Consulting VBE's Products / Services Portfolio: if the VBE has an available product / service portfolio, then it should be accessible for consultation. This process comprises the consultation from a potential customer perspective.

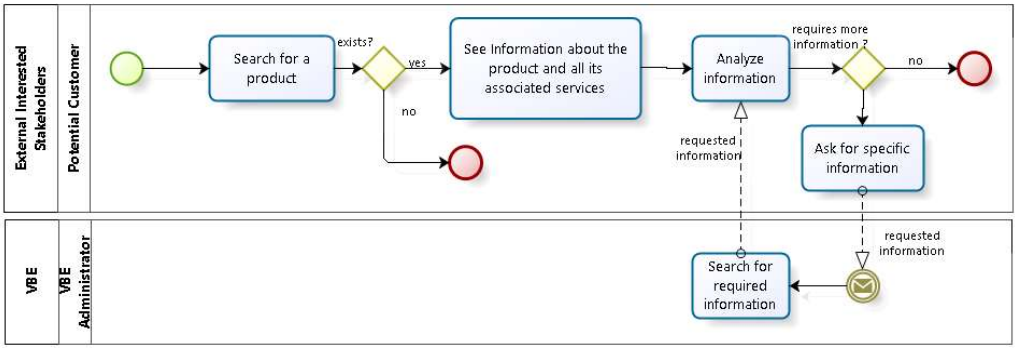

Figure 3.8. BPMN diagram of the consulting of VBE's products / services portfolio process

Management of VBE Performance System: this process comprises the activities for the definition of performance evaluation criteria, evaluation structure, and monitoring evaluation results.

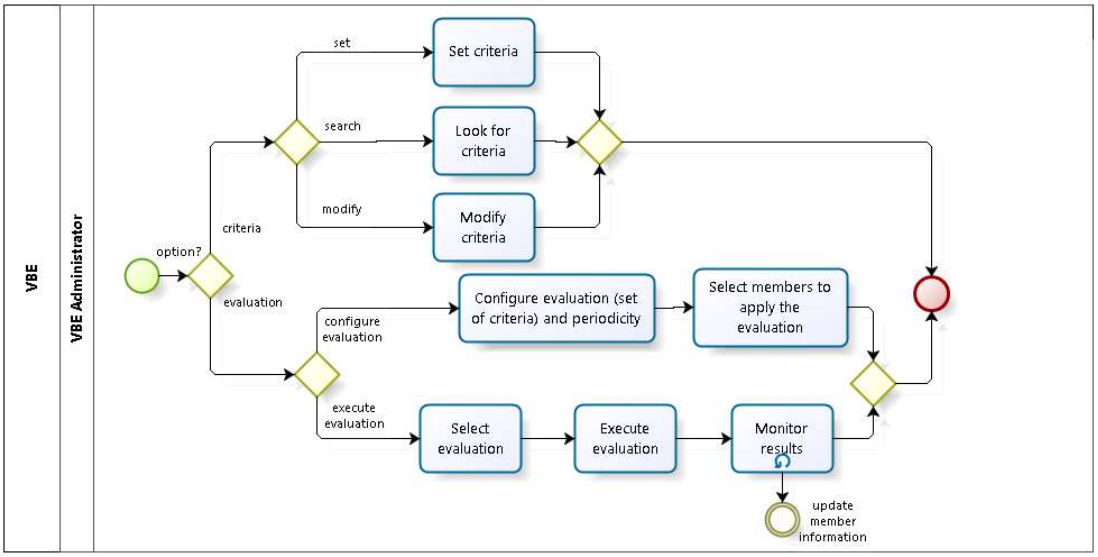

Figure 3.9. BPMN diagram of the management of VBE performance system process

The processes shown above are the main processes that a VBE management system should cover. Nevertheless, additional ones (not shown here) such as the management of the VBE's product/service portfolio process could be available.

3.1.1.3 Conceptual Architecture of a VBE Management System

At a general level, and to comply with the main requirements and processes of the VBE management, a conceptual architecture for a VBE management system was proposed in (Camarinha-Matos et al., 2015b), as illustrated in Figure 3.10.

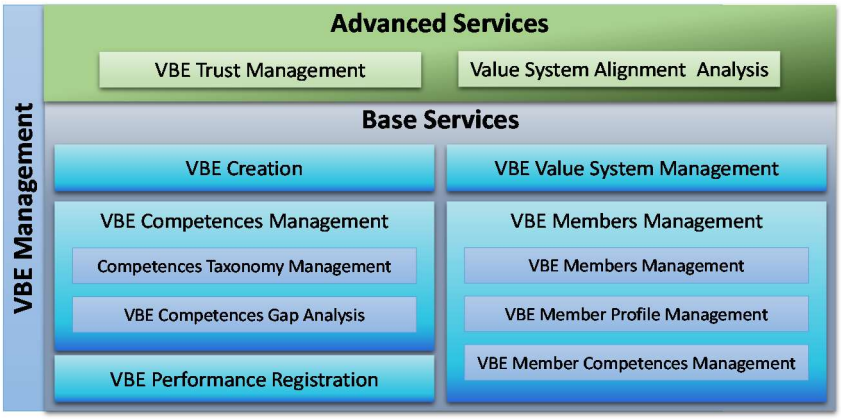

Figure 3.10. Conceptual architecture of the VBE management system

The proposed architecture follows a 2-layer model containing:

— **VBE Management Base Services Layer**

This layer is responsible to provide services for the basic management of the VBE. Such services include:

- VBE Creation: when the creation of a new VBE is planned, a number of preparation steps should be followed. Required functionalities for VBE creation are mainly for its initiation and recruitment of members.
- VBE Competences Management: for a VBE to be as competitive as possible in its domain of operation it should contain a comprehensive set of competences and a corresponding taxonomy to allow a common understanding within the VBE. Therefore, it is important to enable the management of a taxonomy of competences comprising a hierarchical classification of the competences envisaged for the VBE. In addition, it should include services for the analysis of the VBE competences gap, by matching the existing competences of the VBE against the current and emerging needs. Some of these needs might result from the sudden leaving of a VBE member or when considering the demands identified through the existing opportunities in the market/society.
- VBE Performance Registration: keeping the VBE members' profiles updated is essential to make them more prepared for future collaborations. As such, it is desirable to have services that allow the recording of information about the performance of the VBE and its members. The aim is not to cover the functionalities of a standard PMS (Performance Management System), but to link external PMSs with information provided by VBE members. In this way, more complete and accurate members' profile information can be achieved.
- VBE Value System Management: one basic characteristic of a VBE is its value system, thus a set of services to define the mission and values that characterize the VBE should be provided. The result information will be used by the advanced services, namely by the value systems alignment analysis functionalities (as described below).
- VBE Members Management: the management of the VBE members and corresponding profiles and competences is perhaps the most important set of services that a VBE should include to support the VBE administrator. Such services shall provide functionalities for new members admission and registration as well as members withdrawal. Additionally, it should also provide VBE members with functionalities to list the profiles of other members. The usage of such functionalities shall be conditioned by permissions, i.e., while the VBE administrator has full access to all

information, the other VBE members are constrained by specific authorization.

— **VBE Management Advanced Services Layer**
This layer comprises advanced services of the VBE management system that help improving the VBE life-cycle. Two services suggested as examples at this level are:

- VBE Trust Management: the establishment of trust relationships between organizations is crucial to enhance the cooperation among organizations involved in VBEs and their collaboration within the VOs (Camarinha-Matos, et al., 2013f; Unal et al., 2014). Consequently, the existence of services for the assessment of an organization's trust level and to promote the creation of trust between organizations are quite important (Msanjila and Afsarmanesh, 2008a).
- Value Systems Alignment Analysis: The participation in collaborative networks involves risks and often consortia fail due to internal conflicts that can be originated by different prioritization of values. Therefore, the establishment of a common Value System or the effort to align the Value Systems of network members can play an important role in the sustainability of collaboration (Macedo and Camarinha-Matos, 2013). As such, software services to support the analysis of Value Systems and their alignment in a collaborative context are relevant to improve the network management.

3.1.2 VO Creation in a VBE Context

As previously mentioned, our work considers that VBEs are the main recruitment space for VOs creation. Therefore, it is important to highlight, as illustrated in Figure 3.11, that the VBE creation and VO creation are different processes, triggered by different motivations:

— A VBE is created as a long-term association and its members are recruited from the "open universe" of organizations according to the criteria defined by the VBE creators or administrators; and

— A VO is a temporary goal-oriented organization triggered by a specific collaboration opportunity. Its partners are primarily selected from the VBE members, but in case there is a lack of skills or capacity inside the VBE, some organizations can be recruited from outside.

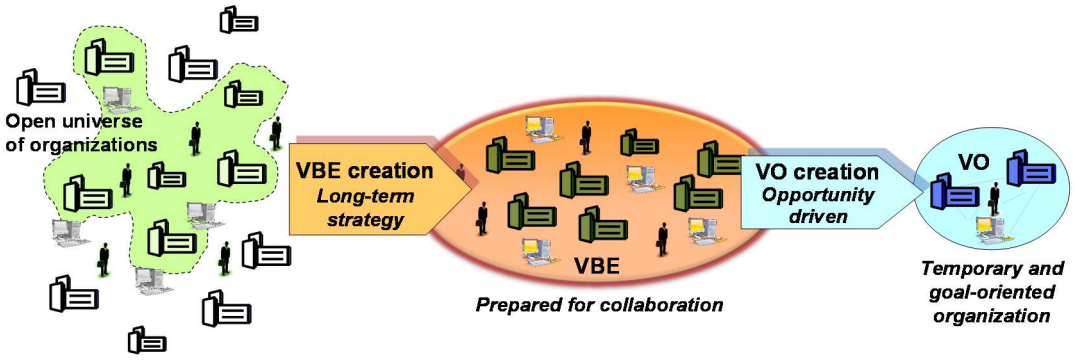

Figure 3.11. VO creation in a VBE context

3.1.3 VO Creation in a "Glocal" Context

There are situations where the geographical context might have great relevance, making the involvement of customers, local suppliers and other local stakeholders with the VBE essential. If on one hand, VBEs potentiate organizations and enterprises to participate in VOs in global markets, benefiting from Internet and other technical means to overcome geographical barriers, on the other hand, geographical vicinity, culture, business environment, legal regulations, etc., can be key factors for the inclusion of customers and their related network/community in the process of creation of new VOs. This is related to the notion of *glocal* enterprise, that considers an enlarged recruitment space for potential partners for a new VO, combining both the long-term strategic network (VBE) and the customer-related community (Figure 3.12) (Camarinha-Matos et al., 2013a; Camarinha-Matos, et al., 2015b). This customer-related community (or customer "network") typically involves the customer and local non-critical component suppliers, service providers, consultants, and a variety of other support entities, e.g. regulators, R&D organizations. As a simple example, in some regions with complicated transportation logistics it is important to resort to local suppliers close to the customer.

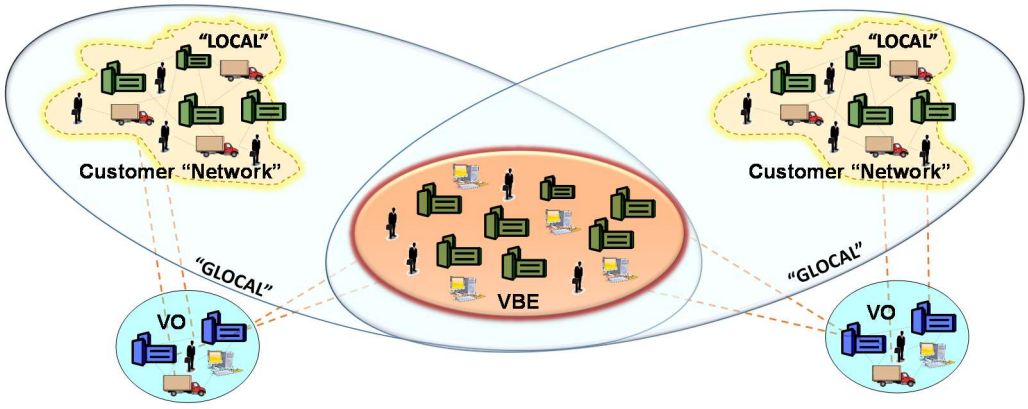

Figure 3.12. *Glocal* enterprise recruitment space

3.2 VO Creation Process

In order to promptly respond to a collaboration opportunity, it is important to properly define the virtual organization creation process (Camarinha-Matos et al., 2009b). This process is triggered by a collaboration opportunity identified during the operation phase of a VO breeding environment. As the VO is typically a short-term organization, its life-cycle is adjusted to the necessary period to fulfill the collaboration needs. As illustrated in Figure 3.13, this period corresponds to its creation, execution of the planned project, and dissolution (Oliveira and Camarinha-Matos, 2010; Romero et al., 2010).

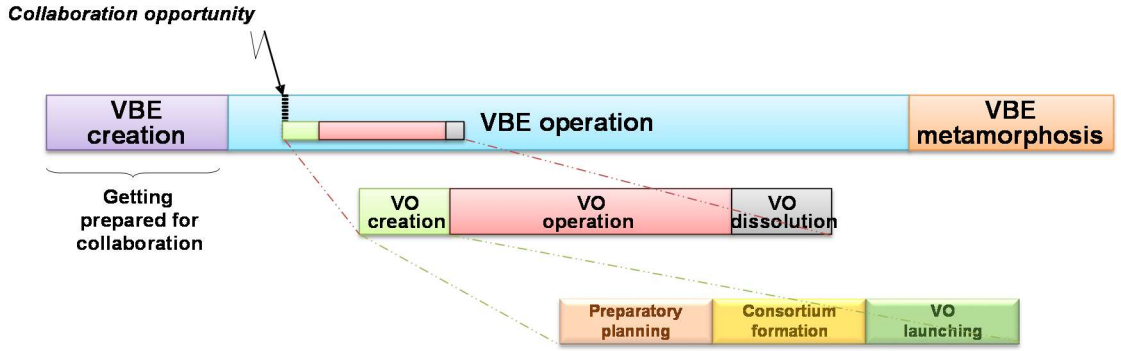

Figure 3.13. VO creation in a VBE context

Apart from the competences that are related to the local suppliers and other local stakeholders, whenever there is a new collaboration opportunity (CO), it is necessary to find the adequate competences inside the VBE. Nevertheless, in case there is a lack of skills or capacity, the VO planner can recruit other organizations (Afsarmanesh, et al., 2008b).

Focusing on the creation phase of the VO life-cycle, there are some stages that are common to all VOs, independently of their focus or domain (Camarinha-Matos, et al., 2005c; Camarinha-Matos, et al., 2008b), such as: preparatory planning, consortium formation, and VO launching. These three stages of the VO creation process are briefly summarized in Table 3.2.

The innovation element of our proposed approach to the creation of virtual organizations relies on having an integrated environment where the VO planner can be assisted along the complete process, starting at the identification of the CO until the consortium formation and VO launching. Along the process, it is desirable to achieve a VO agreement resulting from partners negotiation. In fact, the establishment of internal agreements is one of the foremost negotiation needs, as they will determine the behavior

of the networks, and thus represents an issue of special relevance during the VO creation process (Camarinha-Matos, et al., 2009b). Therefore, different negotiation contexts are important, as negotiation mechanisms might be applied in different stages, namely: (i) during VO creation, either for negotiating with the potential customer, or to negotiate an internal VO agreement; or (ii) for VO agreement amendment, meaning that it can be used for addition or replacement of partners, and changes of roles.

Table 3.2. VO creation – main stages

VO Creation Stage		*Main Focus*
Preparatory Planning	CO identification and characterization	Who? Where and how? Which patterns of collaboration? How to structure the VO? Any initial template model?
	Rough VO planning	
Consortium Formation	Partners search and suggestion	Who? Which criteria? Which base information? Are there profiles? Which decision support?
	Detailed VO planning	Which negotiation process? Which contract, rules, templates? Which agreements?
VO Launching	Contracting	Is there a common infrastructure? Which governing principles? Which detailed plans?
	VO setting up	

Furthermore, the details of the VO creation process are different according to the needs of two distinct cases: *(i)* when there is already an acquired collaboration opportunity, and the objective is just to establish a consortium to fulfill the opportunity requirements; or *(ii)* when it is necessary to go through a quotation process before having acquired the collaboration opportunity.

Figure 3.14 illustrates in more detail the important stages of the VO creation process for an already acquired CO, from its characterization, until its VO set up.

As shown in Figure 3.14, we have suggested that the VO creation process can be divided into three main stages (Oliveira and Camarinha-Matos, 2008):

- The **preparatory planning** stage, that includes:
  - Collaboration opportunity characterization: a step that involves the detailed characterization of a new collaboration opportunity that will trigger the formation of a new VO. A collaboration opportunity might be external, originated by a customer and detected by a VBE member acting as a broker. Nevertheless, some COs might also be generated internally, as part of the development strategy of the VBE.

- Make VO rough plan: determination of a rough structure of the potential VO, namely identifying the required skills and capacities, structure of the tasks to be performed as well as the required organizational form of the VO and corresponding members' roles.

— The **consortium formation** stage starts with the previous characterization and rough planning, and mainly includes:

- Search and suggest partners: step devoted to the identification of potential partners, and their assessment and selection.
- Compose VO: in which the detailed organizational structure is defined and the assignment of roles to VO members is made.
- Negotiation: an iterative process to reach agreements and align needs with offers. It can be seen as complementary to the other steps in the process and runs in parallel with them as illustrated in Figure 3.14.

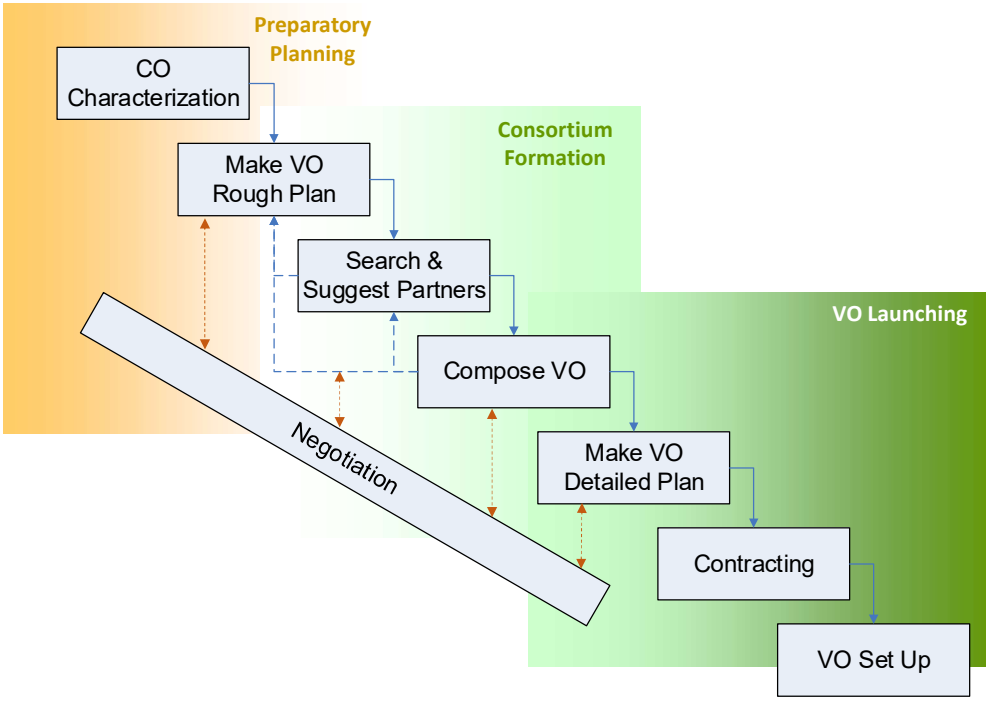

Figure 3.14. Stages of the VO creation process for an acquired collaboration opportunity

— The **VO launching** stage includes:

- Make VO detailed plan: once partners have been selected and collaboration agreements are reached, this step addresses the refinement of the VO plan and VO governance principles.
- Contracting: before the VO can effectively be launched, this stage involves the final formulation and modeling of contracts and agreements as well as the

contract signing process itself. In other words, this step is the conclusion of the negotiation process.

- VO set up: the last stage of the VO creation process, i.e. putting the VO into operation. This stage is responsible for tasks such as: configuration of the ICT infrastructure; instantiation and orchestration of the necessary collaboration spaces; selection of relevant performance indicators to be used; setting up of the VO governance principles; assignment and setting up of resources / activation of services; and notification of the involved members.

The previous description is related to an already acquired CO with the purpose of guaranteeing a VO to fulfill the opportunity requirements. However, before having acquired a CO, there are often some business contexts in which it is necessary to go first through a quotation process. In these cases, as illustrated in Figure 3.15, two major stages can be considered:

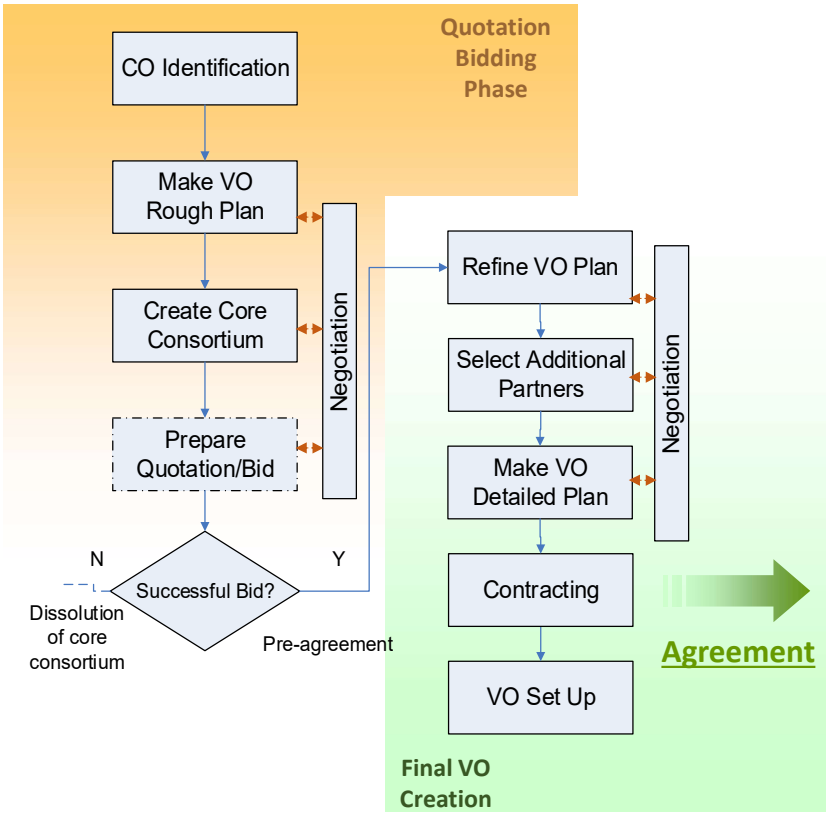

Figure 3.15. VO creation process in case of necessary quotation/bidding

— ***Quotation / Bidding*** – when a collaboration opportunity is found it is necessary to prepare a bid / quotation in order to try to get a contract with the customer. For

the preparation of this bid and assuming that a single organization is not able to satisfy all requirements, it is necessary to make a rough plan of the foreseen VO, and to select the core partners. This initial consortium often prepares the bid together. Therefore, the steps for the preparation of the bid are much similar to the ones described above for the VO creation process for a given CO, but only with the core consortium and main preparatory planning and consortium formation. In case the bid is unsuccessful, the core consortium dissolves; otherwise, the next stage takes place.

— ***Final VO creation*** – In case the bid is successful, the VO's rough plan needs to be revised, based on the specific conditions of the contract with the customer. New additional partners might be necessary, and the VO will be finally detailed and launched. In this case, a refined planning takes place followed by the final consortium formation and finalized by the VO launching.

Following these cases, and benefiting from close interactions with industry end-users networks, several tools were developed in ECOLEAD project by different partners, to cover the core stages of the VO creation process (Camarinha-Matos et al., 2007; Camarinha-Matos, et al., 2008b; Oliveira and Camarinha-Matos, 2008). These tools, included CO identification (COFinder), and CO characterization and VO rough planning (COC-Plan), partners search and suggestion (PSS), and agreement negotiation wizard (WizAN, a contribution of this thesis). These tools also interact with a VBE management system which provides relevant information such as profiles of potential partners, records of previous collaborations (e.g. past performance), etc. As a general approach, the developed framework in ECOLEAD is aimed at assisting the human users in their decision-making. This aim is clearly motivated by end-users requirements, as industry does not easily accept fully automated solutions for consortia formation, unlike what is often proposed in literature. Therefore, the various tools are designed as computer-assisted functionalities and not as a fully automated system.

The main roles involved in this process are the opportunity broker and the VO planner, in the initial stages. Potential partners participate in the last stage of the process. The opportunity broker is the one that is responsible for finding the collaboration opportunity whereas the VO planner is the one responsible for planning and setting up the VO, i.e. responsible for the CO characterization and VO planning, finding the suitable partners, and coordinating the process of reaching the final agreements among all involved parties. Often these two role are performed by the same entity.

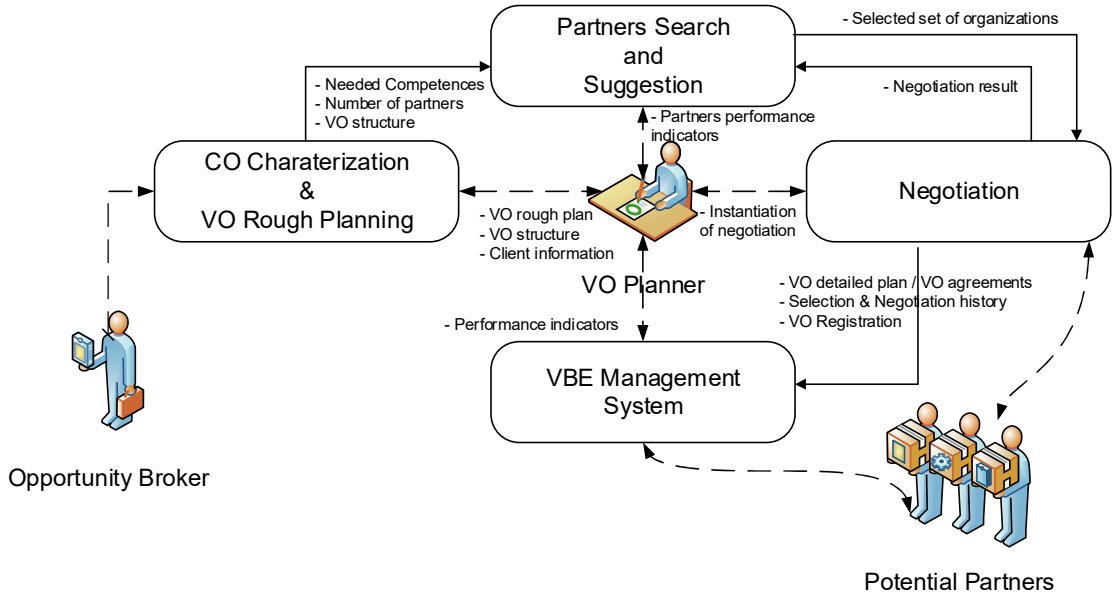

Figure 3.16. Main interactions among VO creation framework functionalities

3.3 Actors and their Dependencies in VO Creation

To properly model the core functionalities of the VO creation process, the main involved actors with the corresponding roles are identified (as active parts in the VO creation process) and summarized in Table 3.3.

Table 3.3. Actors and roles in the VO creation process

Actor / Role	*Description*
Customer	The customer is an individual or an organization that makes a new product order or innovative service request.
Broker	A VBE member that identifies and acquires new collaboration opportunities (business opportunities or others).
VO Planner	A VBE member that in face of a new collaboration opportunity identifies the necessary competences, selects an appropriate set of partners (VBE Members and/or outsiders), and structures the new VO.
Potential VO Internal Partner	A VBE member that is a possible partner of the VO being created.
Potential VO Local Partner	An external interested stakeholder (e.g. Local supplier and Local Support Entity), that is a possible partner of the VO being created. Depending on the nature of the potential VO local partner, there might be different levels of involvement in the collaboration process.
VBE Administrator	Responsible for the VBE operation and evolution. In this scenario, the VBE Administrator provides the VO Planner with the necessary information about the VBE Members profile and competences.

Considering the requirements and actors' roles mentioned in this section, Figure 3.17, illustrates the strategic dependency model for the creation of VOs. This model includes the most relevant dependencies among actors consisting of their goals, soft goals, and exchanged resources. The main goal dependencies are: *start VO creation*; *assess selected VBE members availability*; *negotiate VO details*; etc.

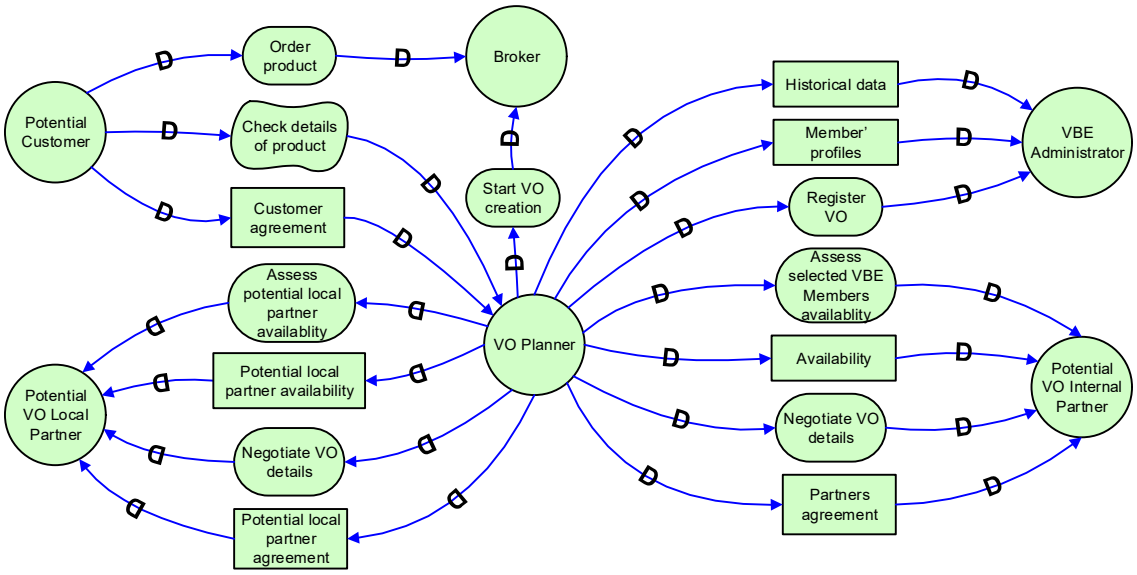

Figure 3.17. Strategic dependency model for VO creation

Figure 3.18 details the internal dependencies of the VO planner to accomplish its dependencies, such as *start VO creation, select partners, register VO,* etc.

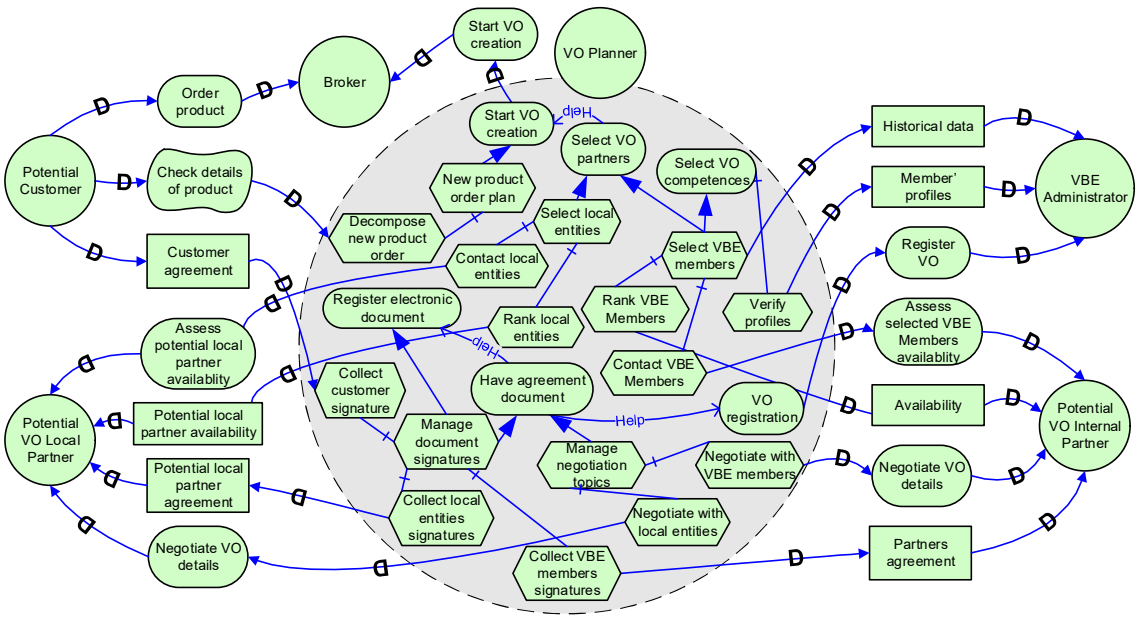

Figure 3.18. Strategic rational model for VO creation (partial view – VO Planner)

Figure 3.19 details the internal dependencies of the potential VO partners (local and VBE members) to accomplish their dependencies, such as *assess new collaboration proposal, participate in VO, check agreement document*, etc.

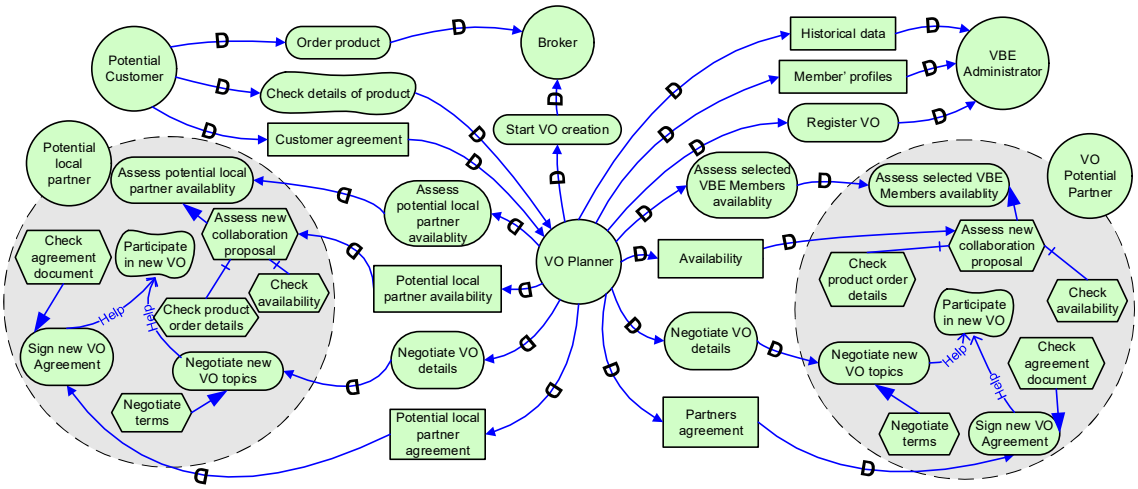

Figure 3.19. Strategic rational model for VO creation (partial view – Potential Partners)

Finally Figure 3.20 details the internal dependencies of the broker and VBE administrator to accomplish their dependencies such as: *product order*, *start VO creation* and *announce new product order* (for the broker); and *VO registration*, *provide VBE members profiles and competences*, *provide VBE members historical data*, etc. (for the VBE administrator)

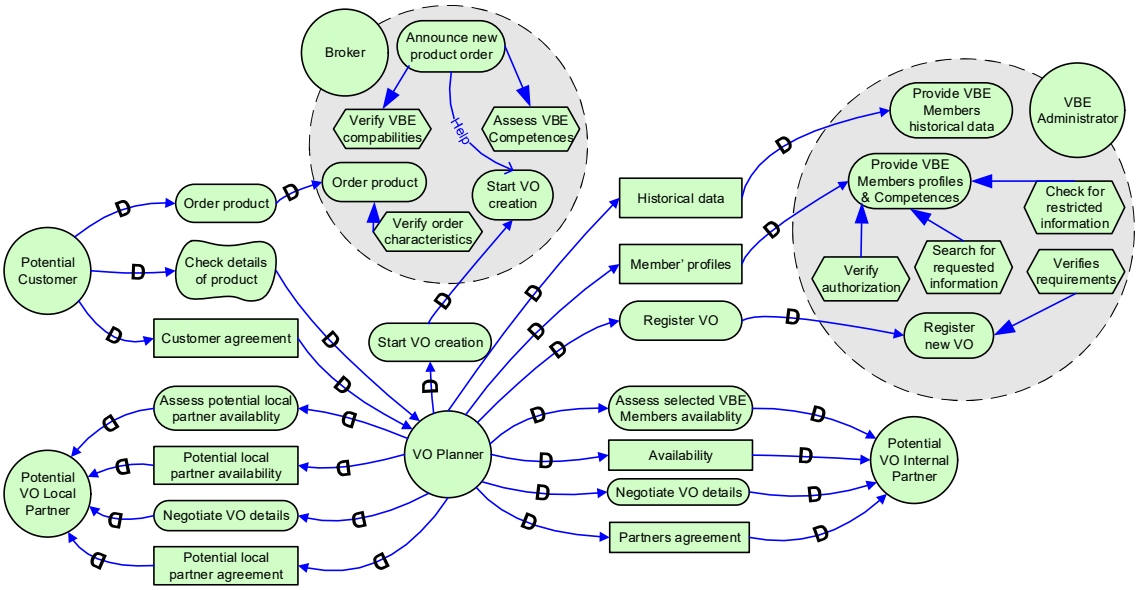

Figure 3.20. Strategic rational model for VO creation (partial view – Broker & VBE Administrator)

3.4 VO Creation Business Process

From the findings in the EU research projects in which the author of this thesis participated, but specially from GloNet (Camarinha-Matos, et al., 2008b; Camarinha-Matos, et al., 2015b), and considering the stages of the VO creation process described in section 3.2, we can consider three main business processes involved. These business processes are suitable both in the case of a given collaboration opportunity (Figure 3.14), or when it is necessary to go through a quotation or bidding process (Figure 3.15), which are: *Preparatory planning of the VO*; *VO consortium formation*; and *VO launching*. In more details:

Preparatory planning of the VO: This business process initiates with the characterization of the new product or service order in terms of its required standards, necessary resources, and required competences. It also considers the planning of a preliminary structure of the new product or service order.

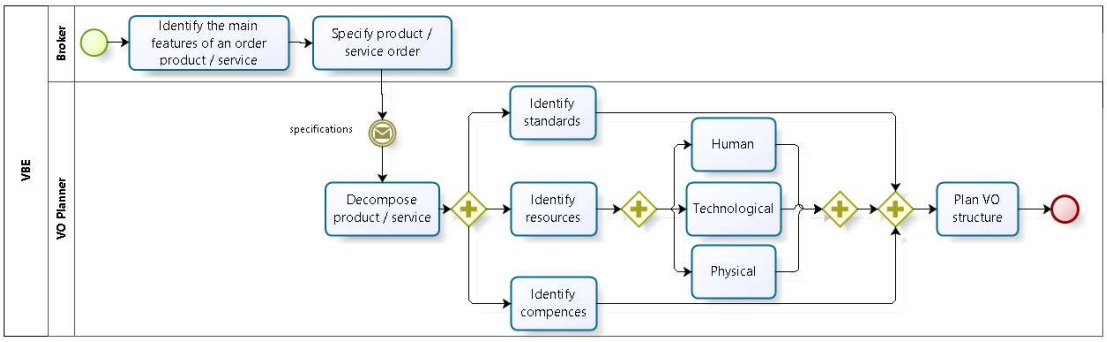

Figure 3.21. BPMN diagram of the preparatory planning of the VO process

VO consortium formation: This business process starts with the analysis of the new product or service plan and includes the necessary phases for partners' selection and negotiation of agreements in order to align needs and offers. This process terminates with the agreement document signing to conclude the formation of the consortium for the new product or service development.

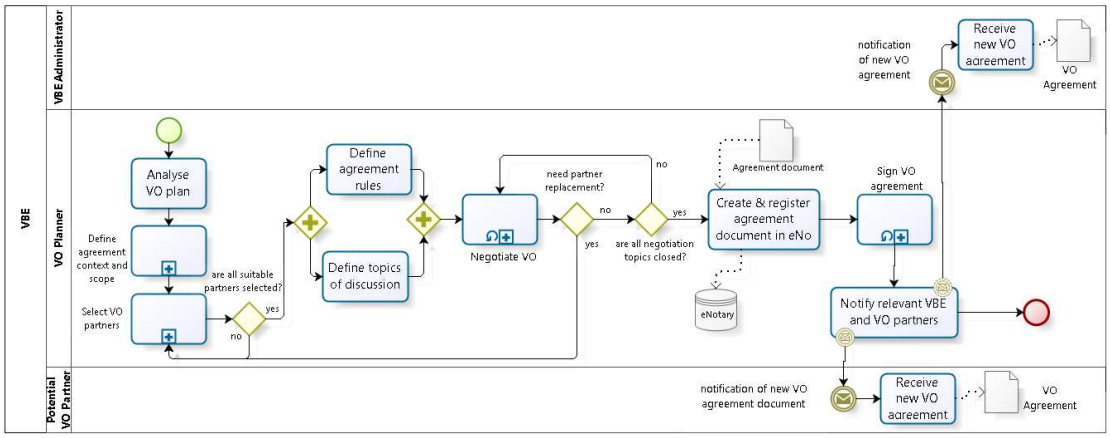

Figure 3.22. BPMN diagram of the VO consortium formation process

Figure 3.23 includes the sub-process for the definition of agreement context and scope of the VO consortium formation.

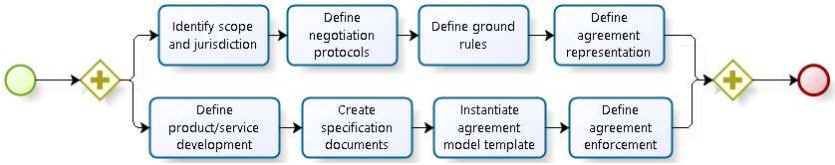

Figure 3.23. BPMN diagram of the sub-process for definition of agreement context and scope

Figure 3.24 includes the sub-process for the selection of partners in the VO consortium formation.

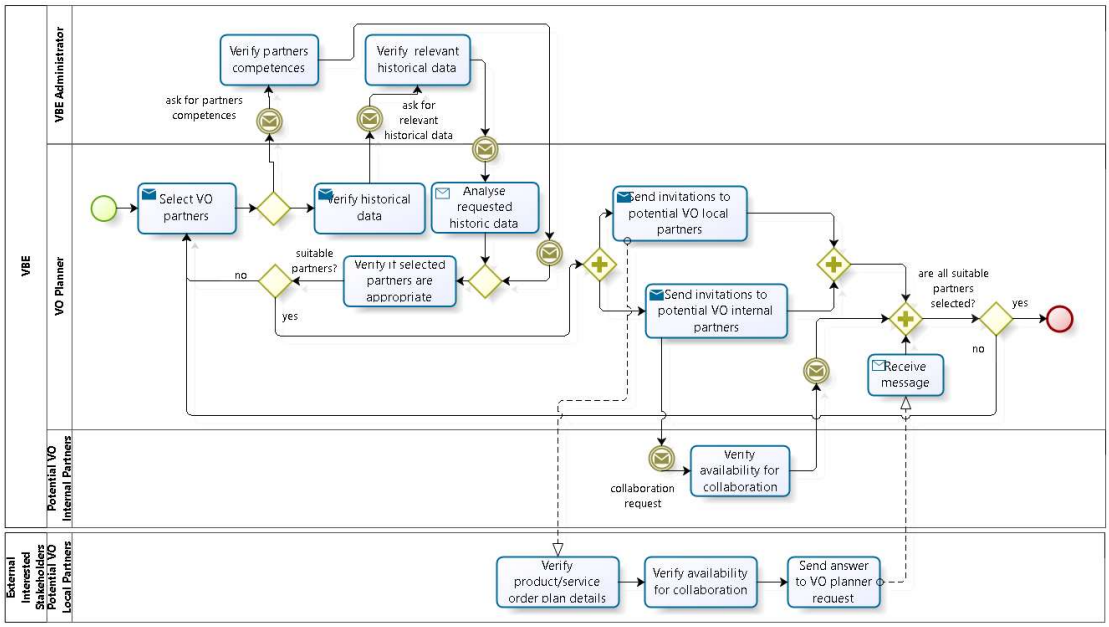

Figure 3.24. BPMN diagram of the sub-process for the selection of VO partners

Figure 3.25 includes the sub-process for the VO negotiation sub-process of the VO consortium formation process.

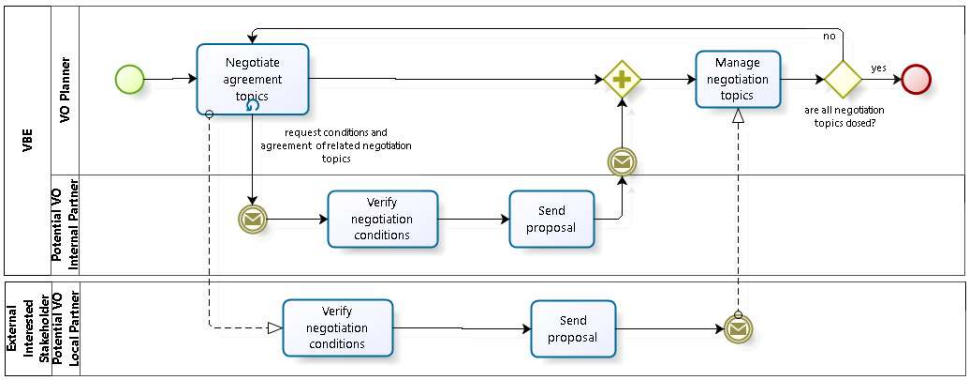

Figure 3.25. BPMN diagram of the sub-process for the VO negotiation

Figure 3.26 shows the sub-process for the VO agreement signing of the VO consortium formation.

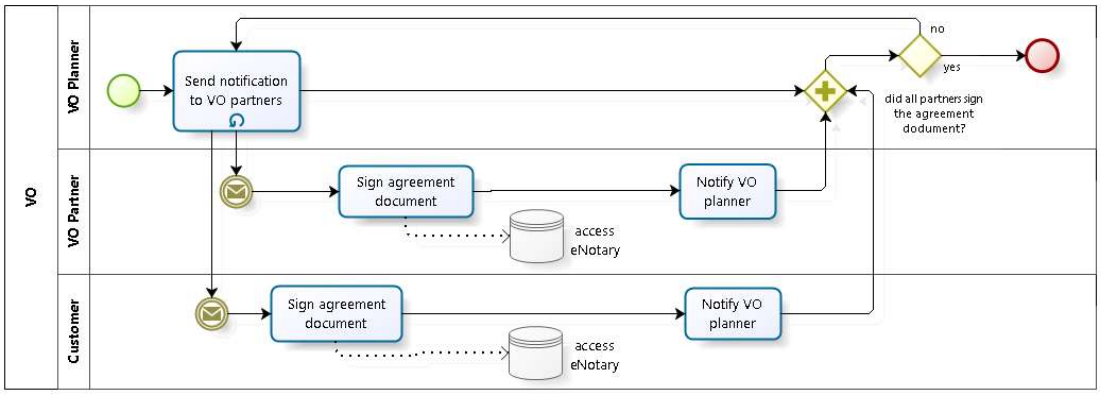

Figure 3.26. BPMN diagram of the sub-process for the VO agreement signing

VO launching: This business process starts with the verification of the instantiation mechanisms to put the VO into operation. The appropriate ICT infrastructure, needed collaboration spaces, relevant performance indicators, and governance models for the VO are established. Before putting the VO into operation, it is registered in the VBE and involved partners are notified.

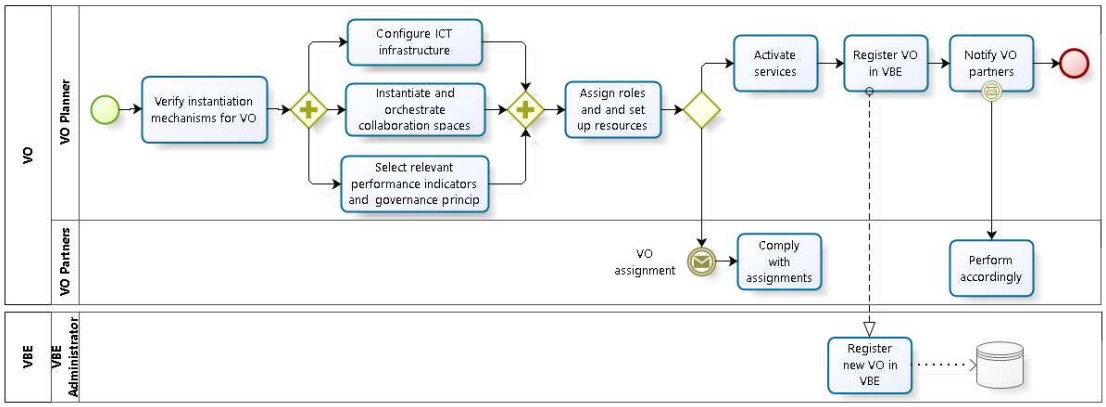

Figure 3.27. BPMN diagram of the VO launching process

The described VO creation process covers the required stages, from the identification of the collaboration opportunity until the actual launching of the VO that will exploit that opportunity. The proposed set of business processes support iterative decision-making in which the final decisions are made by the VO planner. Therefore, the following table describes the main relations between the functionalities of the VO creation and the related goals of the strategic dependency model (i* diagrams: Figure 3.17, Figure 3.18, Figure 3.19, and Figure 3.20) and business processes (BPMN diagrams: Figure 3.21, Figure 3.22, Figure 3.23, Figure 3.24, Figure 3.25, Figure 3.26, and Figure 3.27).

Table 3.4. Synthesis of VO creation

Stage		*Description*	*i* Goals*	*Business Process*
Preparatory Planning		Support the VO planner with means to properly plan and schedule the collaboration opportunity. At this stage, the plan is preliminary and should be adaptable and customizable according to the agreements with the future VO partners.	- Order product - Start VO creation	- Preparatory planning of the VO
Consortia Formation	Selection of appropriated partners	Support the VO planner on the identification of potential partners, their assessment and selection (mainly according to main competences and availability). The search space includes both the long-term base network (VBE), potential local suppliers and other relevant stakeholders.	- Select VO competences - Provide VBE members' historical data - Provide VBE members' profiles & competences - Select VO partners - Assess potential local partners availability - Assess selected VBE members availability	- VO consortium formation - Selection of VO partners

	Negotiation towards agreements	To support multi-stakeholders to iteratively reach agreements and align needs with offers for the virtual organization creation. This includes several negotiation rounds among potential VO partners.	- Select VO competences - Have agreement document - Negotiate VO details - Negotiate new VO topics	- VO consortium formation - Definition of agreement context and scope - VO negotiation
VO Launching	Ensure suitable agreement document	Support users with means to exchange information with a warranty of authenticity and validity as well as providing a safe repository to save and request documentation.	- Have agreement document - Register electronic document - Sign new VO agreement	- VO consortium formation - VO agreement signing
	VO set up	Process of putting the VO into operation. For that, the negotiated and agreed topics are instantiated and the involved partners are notified.	- Register VO	- VO launching

3.5 Conceptual Architecture for a VO Creation Support System

This section proposes a conceptual architecture for a support environment that allows the necessary collaboration among VBE members, local support entities and suppliers, potential customers, and other stakeholders in the VO creation process. The main blocks of the architecture are shown in Figure 3.28.

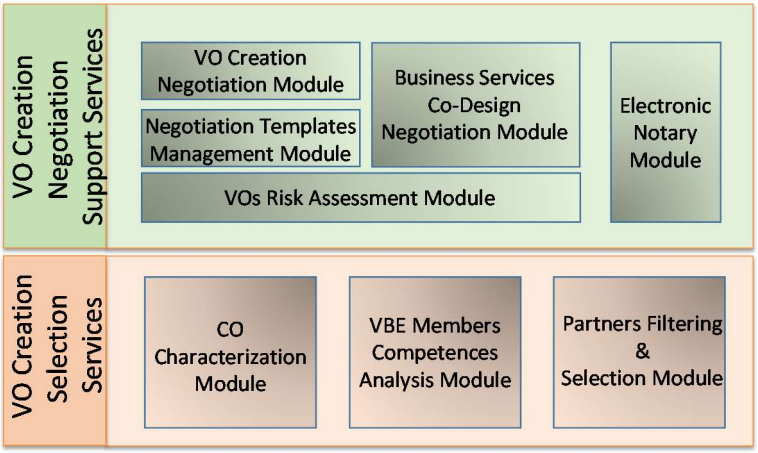

Figure 3.28. Main blocks of the conceptual architecture of the VO creation environment

The proposed architecture adopts a 2-layer model containing:

— **VO Creation Selection Services Layer**

This layer comprises functionalities to adequately choose the most suitable set of partners to form the consortium. As such, it shall take into consideration the requirements for the new VO, which depend on the specifications of the required products or services, so that the VO planner can infer what are the necessary competences that the potential VO partners need to have. Three main functionalities can be highlighted:

- CO Characterization Module: to support the VO planner in the analysis and detailing of orders, both for products and business services. This characterization is based on the decomposition of the order into VO goals, having into consideration the VBE competences taxonomy (Shafahi et al., 2014).
- VBE Members Competences Analysis Module: allowing a matching of the existing competences of the VBE members against the goals of the CO. In this way it is possible to identify the members that are suitable candidates to be part of the VO. The potential partners search space shall primarily include the VBE, as well as external local suppliers and other entities close to the customer (Camarinha-Matos, et al., 2013b).
- Partners Filtering & Selection Module: to generate all possible consortia combinations based on the results of characterization and competences analysis (Oliveira and Camarinha-Matos, 2012). One input for this module should be a list of members (either internal VBE members or local support entities) that are able to accomplish the defined goals. Although, the possible consortia (VOs combinations) can be automatically generated out of the members matching each VO goal, the possibility of manually including "mandatory" or "preferred" partners in all possible consortia is also considered.

— **VO Creation Negotiation Support Services Layer**

This layer mainly consists of the negotiation support functionalities for new VOs. Here both cases of negotiation are considered: a VO for an acquired CO, or a VO for quotation. Support for business services co-design is also considered at this level. Therefore, the main modules identified for this layer are:

- VOs Risk Assessment Module: including functionalities to assess generated consortia, allowing the VO planner to identify and assess the risk level of each potential consortium (Harland, et al., 2003). Making use of the existing VBE

advanced functionalities, this module shall provide a ranking of the potential consortia according to different criteria, for instance: the alignment level of the value systems of potential partners, and the level of trustworthiness of the individual consortium partners (Camarinha-Matos, et al., 2015b). Nevertheless, depending on the application domain, additional criteria can be added. For instance, in the case of logistics-related goals, it could make sense to consider the geographical location of the potential partners (Oliveira and Camarinha-Matos, 2013).

- Negotiation Templates Management Module: to support the management of a collection of agreement templates and a list of pre-defined negotiation topic templates to support the negotiation (Oliveira and Camarinha-Matos, 2010). Also, functionalities to build or edit new agreement skeletons or templates and add them to the collection are considered.
- VO Creation Negotiation Module: facilitating discussions and reaching agreements among VO planner, the customer, and all potential partners of the VO (Oliveira and Camarinha-Matos, 2008; Oliveira and Camarinha-Matos, 2010, 2012). This module includes functionalities for discussing general issues of the VO, and resorts to some virtual negotiation spaces to discuss and agree on specific topics of the VO. The expected main result is an agreement expressing all the settlements reached during negotiation.
- Business Services Co-Design Negotiation Module: to provide a collaboration environment for the co-design of new business services through which the various involved participants can reach agreements. The expected outcome is an agreement representing the consensus reached among the co-design team (Oliveira and Camarinha-Matos, 2014a). Although only co-design of services was considered in the implemented system, the idea could be extended to co-design of products.
- Electronic Notary Module: comprising the necessary functionalities to provide mechanisms for digitally signing documents and the possibility to exchange agreements' documentation with an warranty of authenticity and validity. An archive for such documentation is also considered (Oliveira and Camarinha-Matos, 2012).

As the VO creation process is aimed to take place within a VBE context, all functionalities of the proposed architecture are considered to interact with a VBE management system. Among others, some relevant information elements to be obtained from the VBE management system are: the VBE members' profiles including their value

systems; the VBE members' competences to assess their available capacities and skills; and the level of trustworthiness of the VBE members.

3.6 Electronic Notary and Registry

To regulate the behavioral aspects in VBEs and VOs, every business process and collaboration are supported by agreement related documentation. In this context, where collaboration among geographical dispersed organizations is envisaged, it makes sense to consider a system with the aim of providing electronic notary and registry functionalities for handling such agreement documentation. The fundamental support that such system shall provide to its clients, is the possibility for digitally signing the documents and exchange them with warranty of authenticity and validity.

A core notion in the proposed electronic notary and registry system (e-Notary) is the concept of *Negotiation Dossier* that can be defined as follows:

Definition 2. Negotiation Dossier

*A **Negotiation Dossier** is basically a collection or folder that comprises a set of related documents involved in a negotiation.*

Only a limited number of users will have access to the negotiation dossier, being its access managed by the owner of the dossier, i.e., the user who created it.

As an example, a *negotiation dossier* can be created to maintain all the documentation related to a VO creation, that is the VO agreement and the related supporting documentation. In this case, the actor responsible for the creation of a new dossier is the VO planner, and only the partners of that specific VO will have access to the dossiers' documentation.

Table 3.5 summarizes the main functionalities included in the proposed electronic notary and registry system.

Table 3.5. e-Notary main functionalities

Functionalities	*Description*
User Registration	Any user who wants to use the e-Notary service will be required to previously register in the system. As the notary services rely on an asymmetric key cryptography, at the registration time it is the moment in which the service and the user exchange keys. If the user does not have a pair of keys yet, one can be assigned.
Dossier Registration	This functionality is used to register/create a new dossier in the e-Notary system. The user that registers the dossier becomes the "owner member" and is the one responsible to grant access to other members.
Document Registration	This functionality enables users to include a new document (to be signed) in an existing dossier, associating all members that are required to sign it. Only these members have access to the document.
Document Certification	Functionality used by the document owner to generate a document certificate ensuring that the document is signed by all involved entities. If the document is not signed by all involve entities, the document certificate will contain the information related to those that have already signed the document and information related to how many members still have to sign it.
Dossier Certification	This functionality generates a document certificate validating that all dossiers' documents are signed by all involved members and have a corresponding document certificate.
Document Sign	This functionality allows the user to digitally sign a document. For the signing process, a public-key or asymmetric cryptography mechanism is used. As such, the public key is used to verify a digital signature, whereas the private key is used to create a digital signature.
Document Signature Verification	This functionality is related to a registry functionality with the main objective of guaranteeing that a certain document is an original document and signed by who claims it. For such verification, it is necessary to have the document to be verified and the corresponding document certificate. The certificate is checked with the public key of the member whose signature is being verified.
Request documents	Any registered user is able to request documents that are available for him/her to sign or just for consultation. When a user requests the available documents, the service returns a list of documents and its available associated actions.
Repository	Documents submitted to the e-Notary are saved both for certification and future consultation.

Considering the described functionalities, Figure 3.29 illustrates the strategic dependency model for the electronic notary and registry system that includes the main dependencies between the system and its users (e-Notary clients).

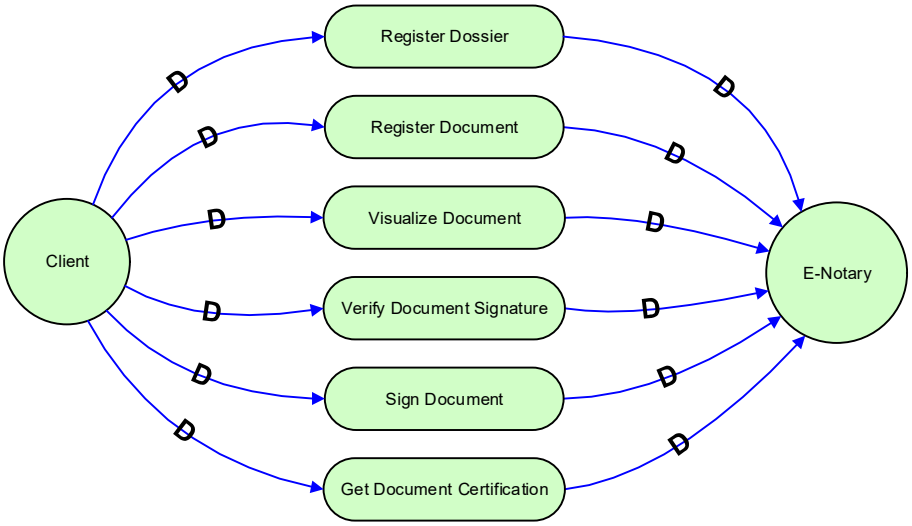

Figure 3.29. Strategic dependency model for the electronic notary and registry system

Figure 3.30 details the internal dependencies of the e-Notary system to accomplish the main dependency goals.

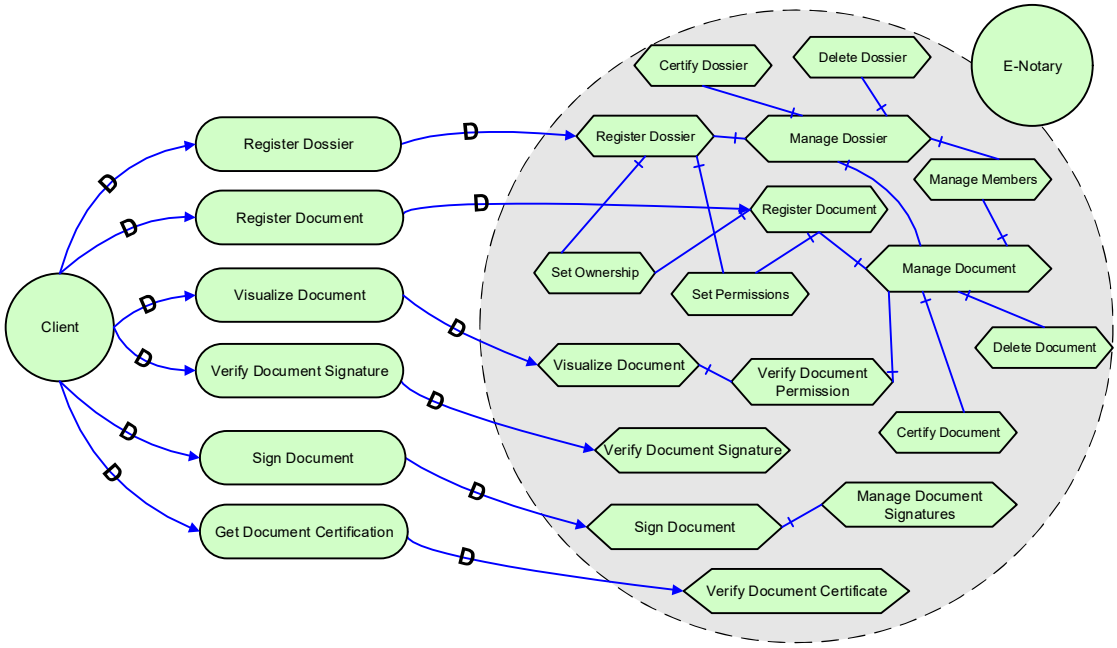

Figure 3.30. Strategic rational model for the electronic notary and registry system

Considering the main functionalities of the e-Notary and the strategic dependency and rational models illustrated in Figure 3.29 and Figure 3.30, there are four main business processes to be considered, namely: *Dossier registration*; *Document registration*; *Document signature*; *and Document signature verification*. In more details:

Dossier registration: This business process initiates with a request from an e-Notary member to register a new dossier. The new dossier is created with the access permissions to other members.

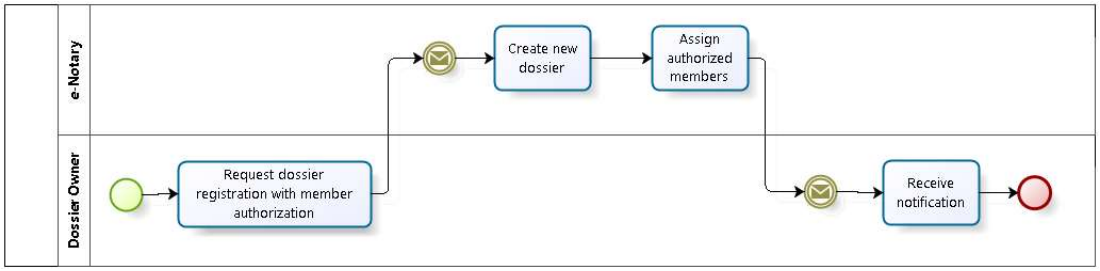

Figure 3.31. BPMN diagram of the dossier registration process

Document registration: This business process starts with an e-Notary member request to add a new document to an existing dossier. The e-Notary system adds that document and grants permissions to all members whose signature is required.

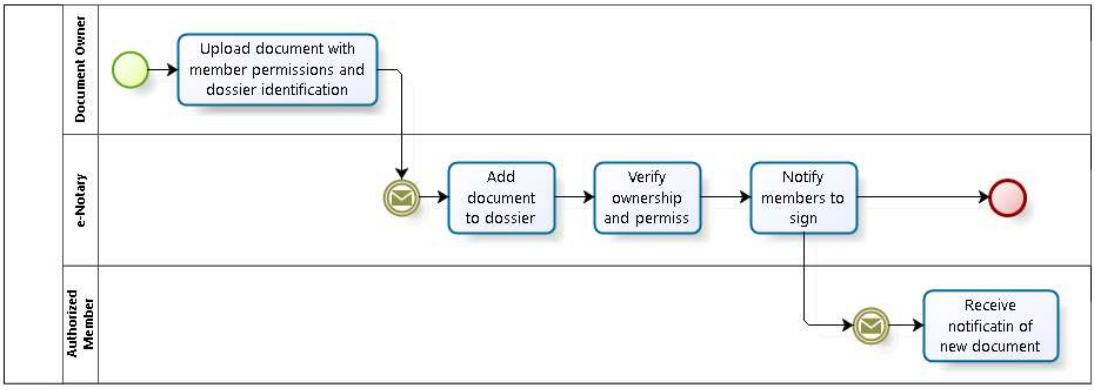

Figure 3.32. BPMN diagram of the document registration process

Document signature: This business process starts with a request to sign a specific document. The e-Notary system, after ensuring that the member is entitled to sign the document, can use a public-key or asymmetric cryptography to perform the signature process.

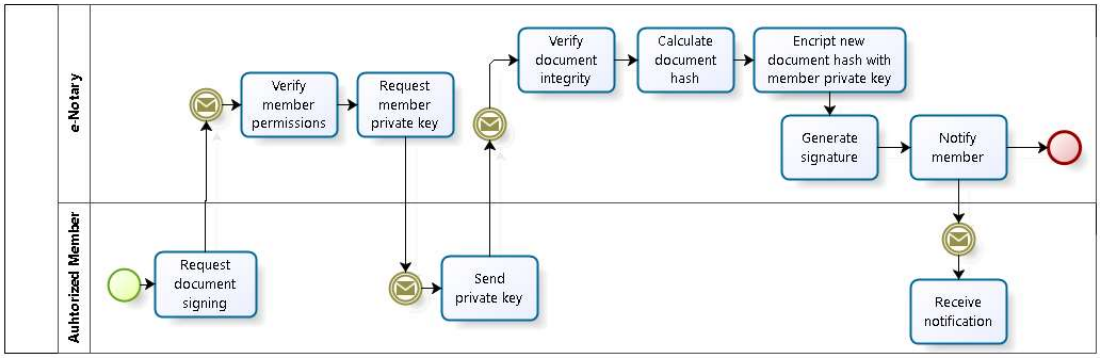

Figure 3.33. BPMN diagram of the document sign process

Document signature verification: This business process starts with a request from an e-Notary member to verify if a specific document is signed by a specific member. For that purpose, the member provides the e-Notary system its public key, the document, and the document certificate. The e-Notary system through a hashing algorithm verifies if the member signature is valid and was used to sign that specific document.

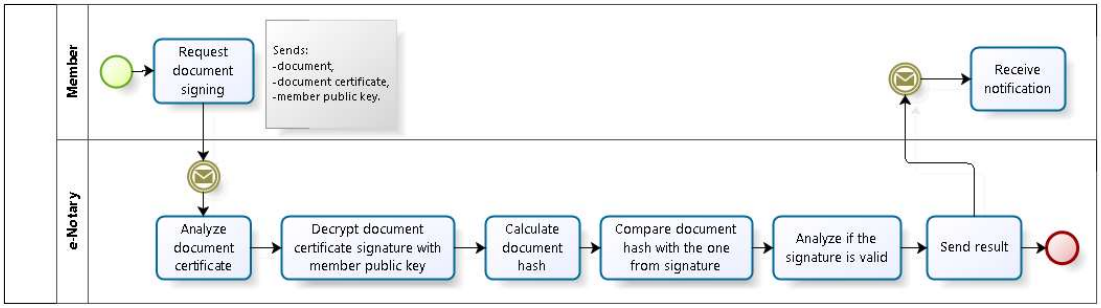

Figure 3.34. BPMN diagram of the document signature verification process

3.7 Brief Summary

The time and amount of resources consumed during the VO creation process whenever a collaboration opportunity is acquired, give a good indication of the level of agility of a collaborative network. The effectiveness of this process mainly depends on the availability of adequate information about potential partners and their level of preparedness for VO involvement. The existence of a VO breeding environment, with its management system, facilitates the fulfillment of these requirements and thus potentiates the VO creation process. Therefore, the agility concept in this context is related to the possibility of combining different competences to adapt to new market opportunities, once organizations' share a common understanding of collaborating principles and technological environment.

Although Figure 3.14 and Figure 3.15 might give the impression that the VO creation is a linear / sequential process, in fact several iterations and parallel activities may take place. At every stage of the VO creation process, there is a flow of information that passes from each stage of the process; and in parallel with the process, the tasks of creating the internal VO agreement are spawned. To assist the VO planner and the VO partners in achieving the VO agreement, a negotiation environment is proposed in section 4.

Also in this chapter, an electronic notary and registry system was proposed to support the digital signing of agreement documents, and exchange them with warranty of authenticity and validity.

4

VO Negotiation Environment

Negotiation is a critical activity that encompasses various stages of the virtual organization creation process. Particularly, negotiations are needed during the selection of partners, determination of their roles and task allocation, definition of the operating conditions of the VO, etc. A synthesis of the conclusions of the negotiation topics can be represented by an agreement among the partners that will participate in the VO. In order to reach such agreement, a negotiation wizard is proposed. Assisted by this wizard environment, organizations are able to negotiate specific topics of the new VO, either in a bilateral way or in a multiparty context.

As described in chapter 3, the VO creation includes a number of steps that go from the new collaboration opportunity identification, to the formation of the new consortium to respond to that opportunity. Although the selection of the adequate partners to form a consortium is of extreme relevance, the consensus that is reached among them is of no less importance since it can serve as the basis for the operating principles of the VO. Therefore, one important activity that runs in parallel with some of the steps of the VO creation process is the negotiation.

Usually contracts and/or agreements are used to regulate the exchange of values (e.g. money, knowledge), and their provisions are mainly for: (i) protection of parties in case that something does not go according to what was planned; and (ii) to describe what was agreed in the case that any party forgets it. In this context, the negotiation process is usually conducted through traditional communication methods like e-mails and phone calls or even face-to-face meetings, which carry delays induced by the participation of many partners. Even if these delays are not too critical within a small

local collaborative network where members share the same language and business background, the situation is completely different for multicultural and geographical widely spread organizations. Consequently, there is a need to improve the effectiveness of the negotiation processes when creating virtual organizations. It is also important to develop forms of e-contracting as they can describe the rights and duties of all virtual organization partners (Rocha et al., 2004), as well as penalties to apply to those that do not satisfy the agreement. Computer assisted negotiation and e-contracting are expected to provide a faster and cheaper solution than standard contracting. Several significant characteristics for the e-contracting process can be found in (Angelov, 2006).

Procedures for e-contracting and negotiation are also important in relation to the ISO 9000 certification as they can ensure clearly defined and repeatable procedures at the CN level and not only within each company.

With this purpose, a computational environment to support the negotiation activity and assist on the agreement establishment is designed and developed. This negotiation environment is intended to provide computer-assisted support to the process of negotiation and reaching agreements during consortia creation, enhancing the efficiency and effectiveness of both the process and the outcome, while allowing flexible human intervention in decisions. The purpose of the tool is not to fully automate the process, but rather to assist the human actors in decision making during the negotiation steps towards the VO establishment.

Definition 3. Virtual Organization Agreement

A virtual organization ***agreement*** *represents the negotiated understandings between two or more parties along the VO creation process. The agreement documents comprise the give-and-take of a negotiated settlement and can be legally enforceable.*

In the process of VO creation, there are two main situations where negotiation might be required: (i) to select the appropriate partners to form the VO, and (ii) to reach agreements on the details of the VO. The proposed negotiation wizard, named WizAN is intended to be suitable for both situations. Although the customer is described as one of the actors involved in the negotiation process, the direct negotiation with the customer is out of the scope of this thesis.

The main result of WizAN is an internal consortium agreement summarizing the results of the negotiations / discussions that are performed during the VO creation process.

In collaborative business relationships, a negotiation might be performed either between two single parties or among several parties (multi-party negotiation). In the proposed environment, both negotiation types are supported.

4.1 Main Requirements in VO Negotiation

Through interaction with various end-user networks that participated in both ECOLEAD and GloNet European projects, various critical negotiation activities were identified (Oliveira and Camarinha-Matos, 2008; Oliveira, et al., 2010):

- The agreement should follow a basic set of standard templates: it is important to depart from common templates, selected for each kind of CO, and extend the selected template to cope with the detailed agreement specifications using "add-on" clauses/sections;
- The agreement should include topics concerning coordination aspects: for instance, who will be responsible for the VO;
- The agreement should include detailed activities and scheduling;
- The information exchange mechanisms should be agreed, i.e. how should information be exchanged among partners, and also which kind of information should be exchanged. These agreements have also a close relationship with the detailed scheduling of activities;
- The agreement should include a detailed costs agreement, i.e. discuss and agree with each partner the value of the part that it will produce or the service it will perform;
- The negotiation agreement establishment should support privacy of proposals, where only the involved partners have access to the information being negotiated;
- The agreement should include the sharing of risks among the involved partners to avoid potential collaboration conflicts; and
- The negotiation environment should provide a mechanism for tracing the history of negotiations.

Having into account this list, it is evident that this type of agreements requires fundamentally decision making by human actors rather than fully automated decision-making. Therefore, in this case, what is addressed is not a complex e-contracting process where the system is capable of automatically generate, interpret, execute, and manage an agreement, but to a certain extent, an environment that is capable of: (i) providing user guidance through the process; and (ii) storing and receiving inputs into an electronic source for later human interpretation. Considering the VBE context

(Afsarmanesh, et al., 2008b) the main actors involved in this process are described in Table 4.1.

Table 4.1. Actors involved in the negotiation support environment

Actors	*Description*
Customer	Individual or organization that makes a new product/service order or innovative service request.
VO Planner	VBE member that in face of a new collaboration opportunity identifies the necessary skills and capacities, selects an appropriate set of partners (VBE members and/or local support entities), and structures the new VO.
Potential VO Partner	VBE member that is a possible partner of the VO being created.
	VBE External interested stakeholder (e.g. local support entity), that is a possible partner of the VO being created.

The situation of participants being in different environments, having different cultures and different objectives has to be considered so that it is possible to instantiate proper mechanisms for negotiating depending on different contexts. For that, fundamental topics emerge (Oliveira and Camarinha-Matos, 2010):

- Identifying network members whose agreement is necessary;
- Identifying the scope and (legal) jurisdiction of the network;
- Negotiating the ground rules to define the main behaviors of participants during negotiation;
- Discussing administration and allocation of responsibilities;
- Negotiating the decision rules for closure of an issue;
- Identifying a system for resolving impasses; and
- Identifying a decision process for ending the network.

4.2 Negotiation Flow in VO Creation

In the proposed environment, the full negotiation process is guided by an "agreement template" composed of a number of sections, whereas each section refers to a specific topic to be addressed in the negotiation. The agreement template can be built according to the VO requirements and negotiation context.

Definition 4. Agreement Template

Template to guide the VO creation negotiation process, resulting in the virtual organization agreement. It includes sections related to the VO requirements and negotiation context.

Therefore, every issue that is subject of negotiation is called *negotiation topic*. Conceptually, when a negotiation topic is created it is associated to a specific section of the agreement where a link to the topic is kept, as illustrated in Figure 4.1.

Definition 5. Negotiation Topic

Any specific subject or clause that the VO consortium shall agree on.

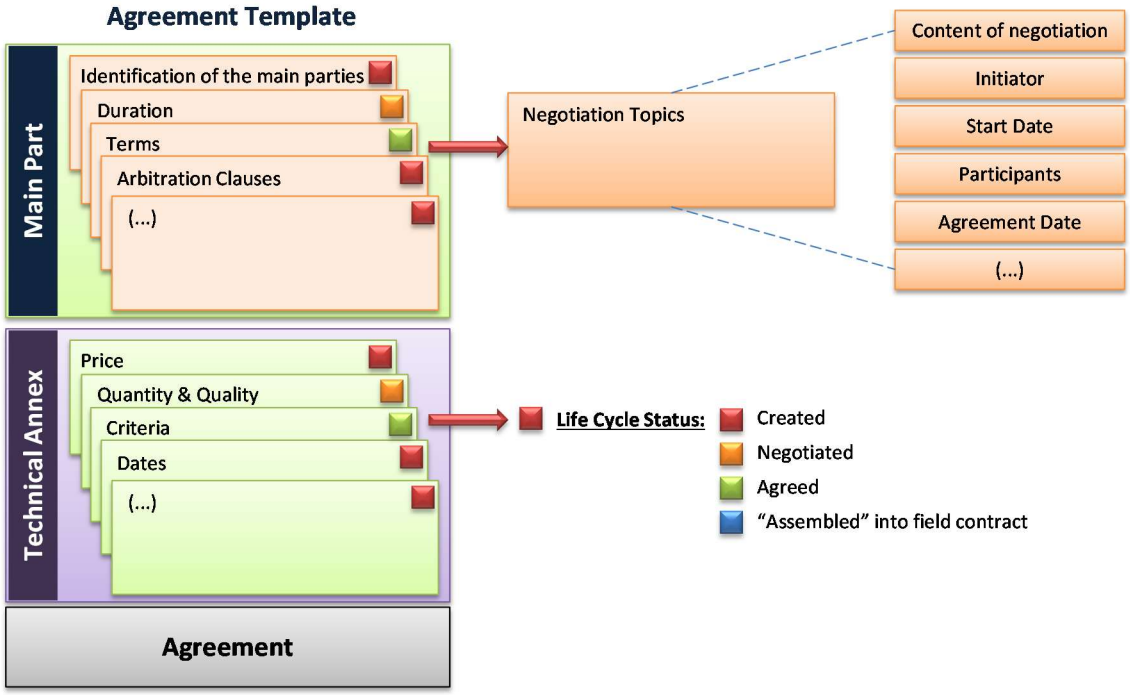

Figure 4.1. Agreement template and negotiation topics

For each negotiation topic a *virtual negotiation space* is created. This is similar to what other authors call *virtual negotiation table* (Cellary et al., 1998; Felfernig et al., 2012; Alfonso, et al., 2014) and it is the "place" where the topic is discussed / negotiated among the involved participants.

Definition 6. Virtual Negotiation Space

A virtual negotiation space (VNS) is a virtual and controlled environment where negotiation topics are negotiated, and related documents are included. Only partners with permission are able to access a virtual negotiation space, being the permission granted by the VNS initiator.

Once all negotiation topics are agreed, the composite agreement can be assembled into a document that represents a "compilation" or integration of the agreements

reached on all negotiation topics. In terms of workflows and protocols, the negotiation process is quite difficult to structure since several flows depend on decisions made by the human negotiators (Buttner, 2006) and also their individual timing (mostly asynchronous regarding each other). Therefore, WizAN is designed to allow considerable flexibility regarding this process.

A simplified negotiation process in VO creation (for an acquired collaboration opportunity, as described in section 3.2) can be represented as illustrated in Figure 4.2.

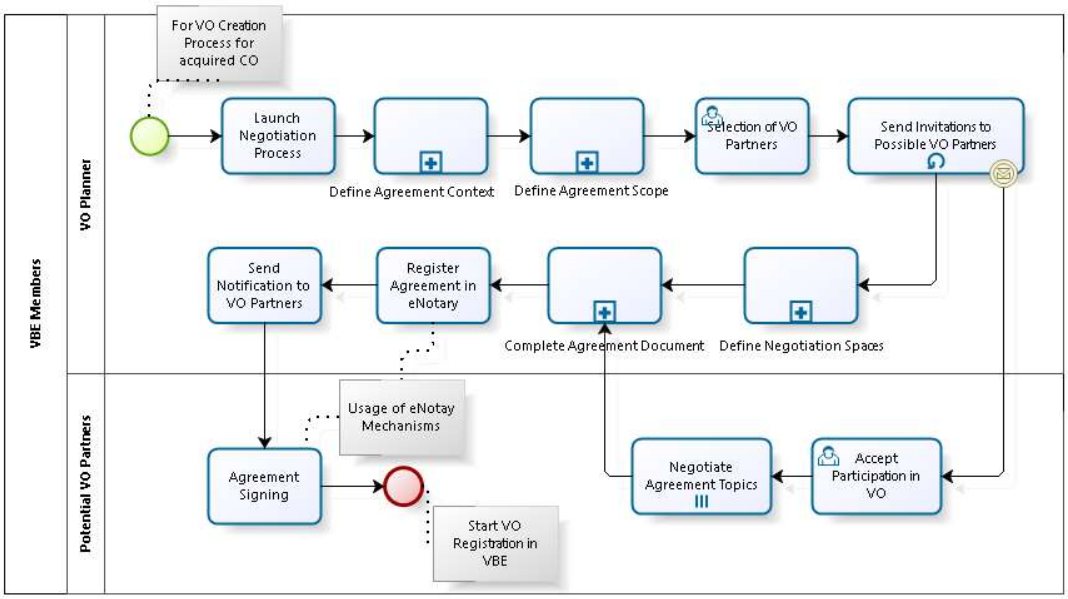

Figure 4.2. Simplified view of negotiation within the VO creation process

Being Figure 4.2, a simplified view of the negotiation activities within the VO creation process, Table 4.2, details the main sub-processes.

Table 4.2. Main negotiation sub-processes in VO creation

Task	*Sub-Task*
Define agreement context	– Identification of scope and jurisdiction; – Definition of negotiation protocols; – Definition of ground rules; and – Definition of agreement representation.
Define agreement scope	– Creation of specification documents; – Instantiation of agreement model templates; and – Definition of agreement enforcement mechanisms.
Define negotiation spaces	– Creation of negotiation topics; and – Definition of agreement rules.
Complete agreement document	– Inclusion of agreement scope and legal jurisdiction; and – Synthesis of negotiation topics.

4.2.1 Collaboration Spaces in VO Creation

Along the negotiation steps during VO creation, there are clearly two important levels: creation of the general information part of the VO agreement, and consequently, in parallel the generation of specific negotiation topics that need agreement.

When the VO planner wants to discuss/negotiate a specific topic with potential partners, a virtual negotiation space is created inside the VO space. This virtual negotiation space is a collaboration space to which the potential partners of the VO are invited to join in order to discuss the necessary topics that need agreement. Here the notion of collaboration space appears significantly important because more than a usual meeting room to enable brainstorming, it also supports collaborative work, mediated by technology, among a group of geographically disperse actors (Camarinha-Matos et al., 2015a).

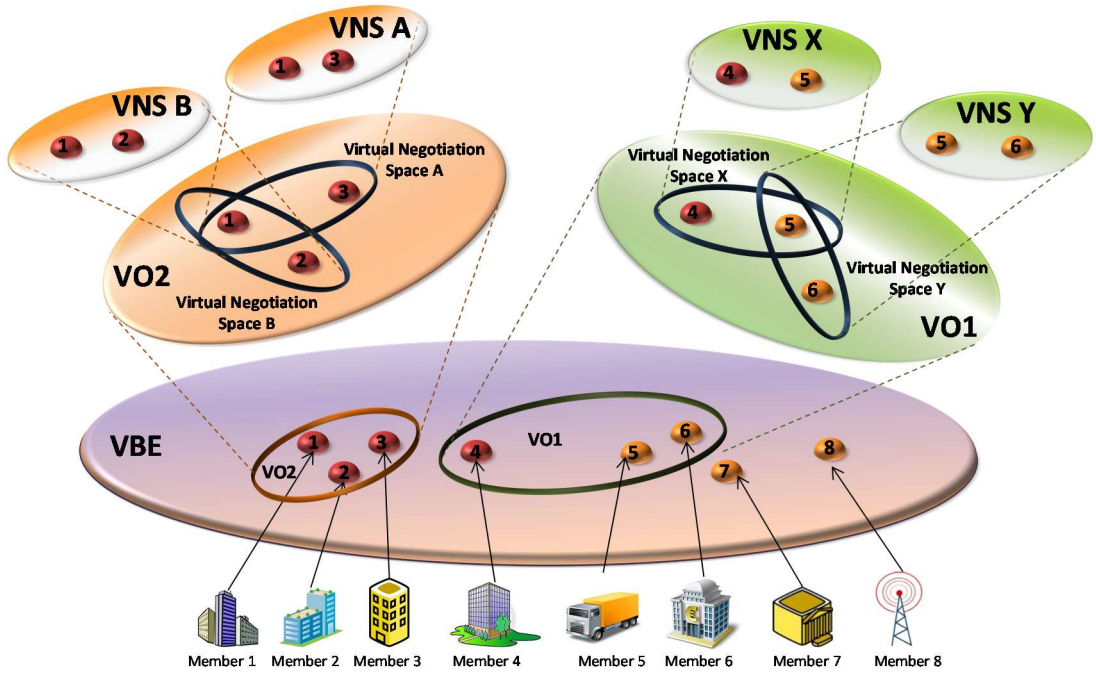

Figure 4.3. VOs and virtual negotiation spaces in VO creation

In this context, it can be considered that the VBE is a collaboration space for VBE members and that each time a new CO appears, a new collaboration space for a new VO is created. Furthermore, during the process of creating a VO, several negotiation processes typically need to be carried out with different sub-groups of potential partners. Each group needs a separate space to privately negotiate the issues related to that group. Hence, various collaboration spaces (representing virtual negotiation spaces) can be dynamically created in association to a VO creation stage. Figure 4.3 illustrates

this approach. Depending on the nature and scope of each topic that needs discussion, as illustrated in Figure 4.3, not all potential partners are invited to all topics, but only the relevant ones.

4.2.2 Main Phases of VO Negotiation

In line with the description in section 3.2, negotiation starts in the preparatory planning phase of the VO creation process. It has its main activity during the consortia formation phase, ending during the VO launching phase (for the specific case of having an acquired collaboration opportunity). Along the negotiation process, there are some main phases with its set of virtual negotiation spaces for each topic that requires negotiation. These phases are described in Table 4.3.

Table 4.3. VO negotiation main phases

<table>
<tr><th colspan="2">VO Negotiation Phases</th><th colspan="2">Description</th></tr>
<tr><td colspan="2">VO Negotiation Preparation</td><td colspan="2">When the VO planner makes the general characterization and planning of the VO. Also at this stage, the VO planner can select the VBE members with adequate competences and generate a list of potential consortia. Then the VO planner can select the most suitable consortium and even add or remove partners according to preferences. At this stage, the VO partners have no involvement.</td></tr>
<tr><td rowspan="2">Ongoing VO Negotiation</td><td>Negotiation Topic Under Negotiation</td><td>While the related negotiation topic is being discussed among partners.</td><td rowspan="2">When the VO planner creates the necessary virtual negotiation spaces for the related negotiation topics. Only the necessary VO partners are involved.</td></tr>
<tr><td>Negotiation Topic Closed</td><td>Once partners agree on the specific negotiation topic and no more discussion is necessary, the VO planner can close the virtual negotiation space.</td></tr>
<tr><td colspan="2">VO Negotiation Concluded</td><td colspan="2">After all virtual negotiation spaces are closed, the VO planner generates an agreement proposal document to be accepted by all partners.</td></tr>
<tr><td colspan="2">VO Negotiation Closed</td><td colspan="2">When all partners have agreed upon the proposed agreement and accepted it. Hereafter, the VO planner creates the final Agreement Document and all VO partners are notified to sign it.</td></tr>
</table>

Figure 4.4 illustrates the described main phases of VO negotiation with its virtual negotiation spaces, including the main interactions of the involved actors, where:

— The first layer includes the main interactions of the VO planner in the four phases of the VO negotiation process;

- The second layer includes the main interactions of the VO partners in the VO negotiation process;
- The third layer includes the main interactions of the VO planner in the negotiation of specific topics; and
- The fourth layer includes the main interactions of the VO partners in the negotiation of specific topics.

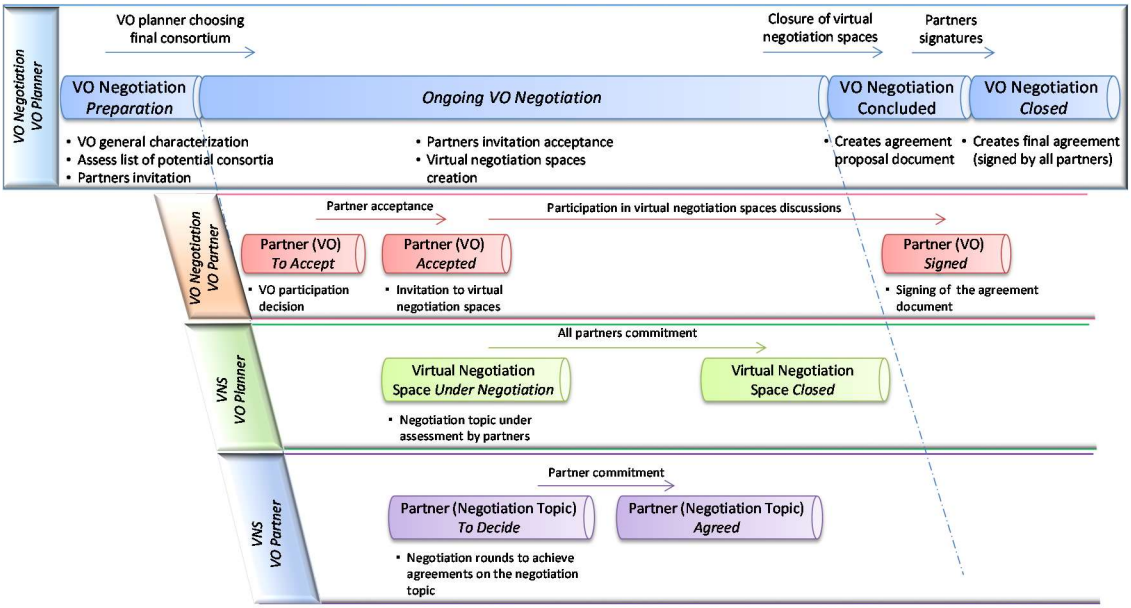

Figure 4.4. VO Negotiation main phases and involved actors

It must be noted that Table 4.3 and Figure 4.4 summarize and illustrate the optimal case where the selected partners are suitable and all agree with the proposed negotiation topics. Nevertheless, in case of need, the VO planner can invite or replace partners during the ongoing VO negotiation phase, and can cancel or refine some negotiation topics (as shown in the protocol of next section).

4.3 Adopted Negotiation Protocol

The process of reaching consensus among the various participants in a negotiation needs to follow a determined protocol in order to be effective (Prakken, 2010). In this specific case, a rule-based approach (Caminada and Amgoud, 2007), making use of a particular logical language was followed to define the negotiation protocol. The negotiation protocol is used to specify when a particular *move* can be made in the course of the negotiation dialogue (Moschoyiannis, et al., 2009).

Move *is the statement and/or decision that a participant can make in the course of a negotiation dialogue.*

Although there are different protocols for negotiation, and different moves designed for different scenarios (Wang, et al., 2014), the benefit of the proposed protocol is that it is generic and can be used when addressing different negotiation contexts (Oliveira and Camarinha-Matos, 2015). As each participant can simultaneously be part of several negotiations of new VOs, that in turn include their corresponding negotiation topics, the adopted protocol relies on the following moves:

$$M_{(N)} = \{request(N), accept(N), refuse(N), withdraw(N)\}$$

being:

- $M_{(N)}$ the set of moves allowed to the participants in the negotiation of a new VO, where:
  - N stands for the specific VO negotiation.

and

$$M_{(NT,K_{NT})} = \{propose(NT, K_{NT}), accept(NT), refuse(NT), counterpropose(NT, K_{NT}), withdraw(NT)\}$$

being:

- $M_{(NT,KNT)}$ the set of moves related to a participation in a virtual negotiation space, where:
  - NT represents the virtual negotiation space, and
  - KNT represents the content associated to NT (negotiation topic).

While participants can make several of the mentioned moves in the course of a negotiation dialogue, they have to do it in a pre-determined way. They may even have to wait for the other participants' moves so that actions can be made accordingly. For example, an evident restriction is that a participant cannot accept to participate in a negotiation of a new VO creation without the VO planner requesting its participation in advance. Table 4.4 summarizes the relevant pre- and post-conditions for the moves considering the participation on the negotiation of a new VO creation.

Table 4.4. Pre- and post- conditions for the negotiation protocol in VO creation

Move	*Pre- and Post- Conditions*
m1: request(N)	**pre**: no condition **post**: accept(N), or refuse(N)
m2: accept(N)	**pre**: request(N) **post:** other moves are consequence of certain triggers (e.g. propose(NT))
m3: refuse(N)	**pre:** request(N) **post:** no further moves may occur from the participant that makes the move refuse(N)
m4: withdraw(N)	**pre:** request(N) followed by refuse(N); or refuse(NT) on the negotiation of a specific topic **post:** no further moves may occur from the participant

Similarly, Table 4.5 summarizes the pre- and post-conditions of the moves related to the participation in virtual negotiation spaces.

Table 4.5. Pre- and post- conditions for the negotiation protocol related to negotiation topics

Move	*Pre- and Post- Conditions*
m5: propose(NT)	**pre**: *accept*(N) **post**: accept(NT), or refuse(NT), or counterpropose(NT,K_{NT})
m6: accept(NT)	**pre**: propose(NT) **post**: other moves are consequence of certain triggers (e.g. : *counterpropose(NT,*K_{NT}*)*)
m7: refuse(NT)	**pre**: propose(NT) **post**: no further moves may occur from the participant that did *refuse(NT)*
m8: counterpropose(NT,K_{NT})	**pre**: propose(NT) **post**: may be followed by propose(NT), or accept(NT), or refuse(NT)
m9: withdraw(NT)	**pre**: refuse(NT) **post**: may be followed by a *withdraw(N)* in case there is no other move allowed for the specific participant

Figure 4.5 synthetizes the relations among the described moves according to the pre- and post-conditions (solid line arrows). The dash arrows represent some moves that the system internally performs as a consequence of previous moves.

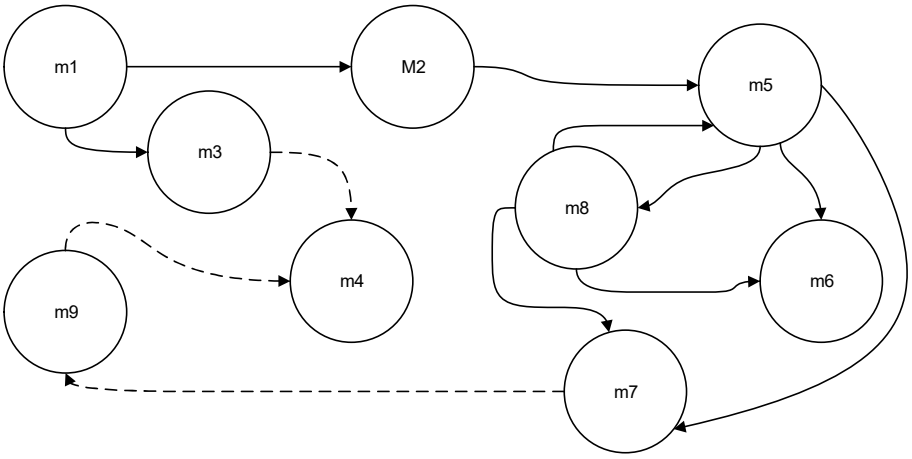

Figure 4.5. Relation of negotiation moves

As mentioned, moves are always related to the negotiation actors' states or actions. Figure 4.6 illustrates the moves related to the VO Planner's possible states and/or actions.

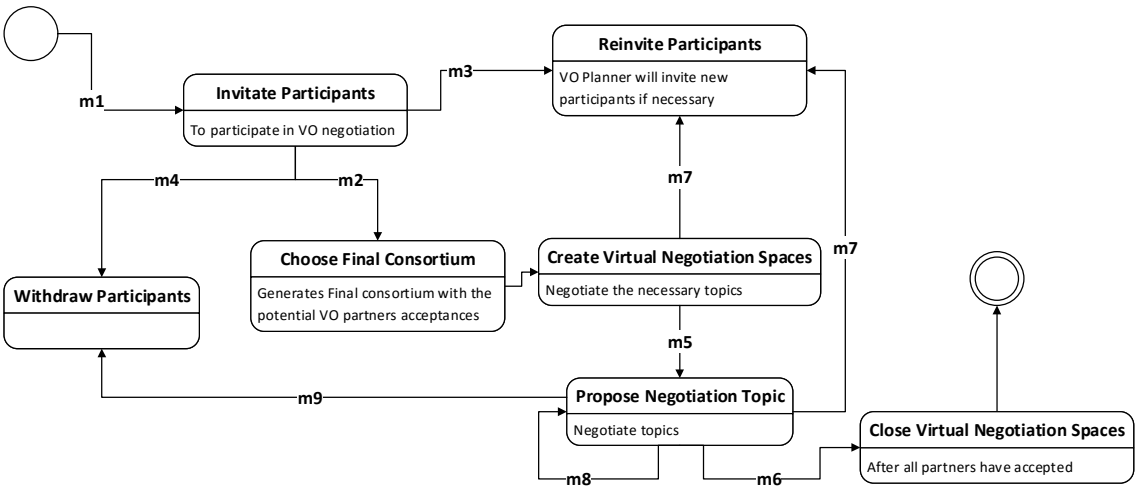

Figure 4.6. VO planner states and related negotiation moves

From another perspective, Figure 4.7 shows the moves considering the possible states and/or actions of the potential VO partners.

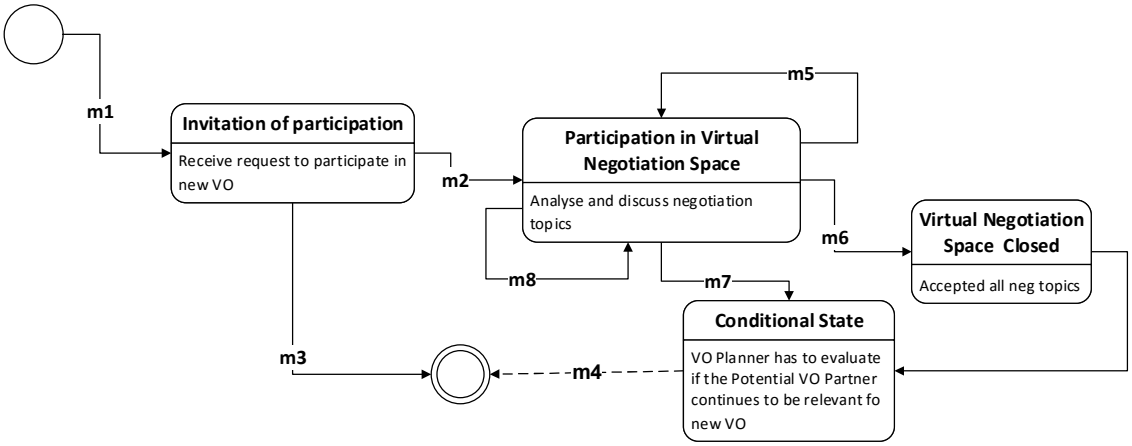

Figure 4.7. Potential VO partner states and related negotiation moves

4.4 Negotiation Support Environment for VO Creation

To facilitate the negotiation of a new VO, WizAN is designed and proposed as the negotiation support environment. The main inputs for WizAN are collected along the various steps of the VO creation process, as illustrated in Figure 3.14 and Figure 3.15. These inputs result from the modules of the VO creation selection services layer described in section 3.5, and include for instance: CO identification (customer and other relevant data about the CO); the suggestion of the needed competences, etc.; and a suggested list of the most suitable configuration of partners to fulfill the CO requirements.

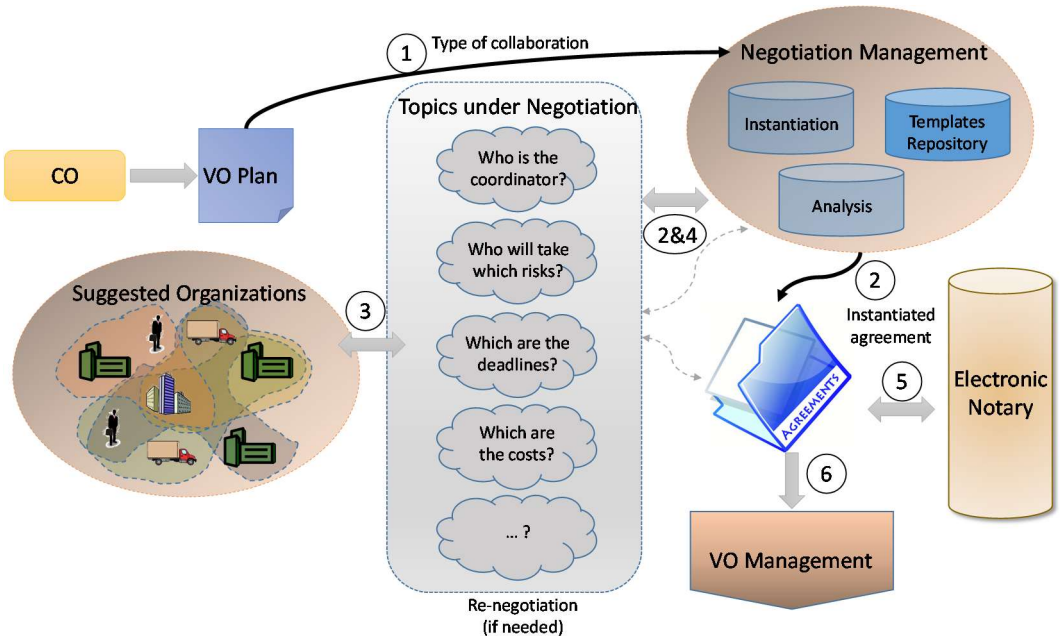

Figure 4.8. WizAN usage scenario illustration

Figure 4.8 illustrates a rough flow of the negotiation steps during a VO creation process and Table 4.6 describes the main interactions (Camarinha-Matos and Oliveira, 2006).

Table 4.6. Description of WizAN usage scenario illustration

Steps	*Description of WizAN usage scenario illustration*
1	It is necessary to know the type of collaboration that a specific CO requires, since this information is essential to conduct the rest of the negotiation. The main inputs for negotiation are: CO identification (customer and other relevant data); suggestion of needed partners; definition of main processes; etc.
2	With this information, the VO planner through WizAN can select a suitable negotiation template and also instantiate some general negotiation topics for the specific type of CO.
3	In parallel with the negotiation template instantiation, the partners search and suggestion process is performed. The main input for negotiation is a list with a configuration of the most suitable partners for the VO (considering corresponding competences, other selection criteria and performance indicators).
4	Instantiation of the necessary virtual negotiation spaces for the negotiation of each relevant topic. At this point, it is necessary to reach agreements concerning rights, duties, responsibilities, etc.
5	Compilation of the agreed outcomes of all negotiation topics, generating the consortium agreement. The VO agreement is thus the "assemblage" of all relevant information about the VO that was agreed by the involved participants. This information is structured into several sections according to their categories. For example, there might be a section related to the partners involved in the VO; a section with the scheduling of the entire VO; a section specifying the tasks where certain parties are involved as well as their obligations and rights; etc. At this point, tools to support the writing of documents, as well as e-Notary functions can be used.
6	Manifestation of the agreement document into the VBE management system so that the VO can proceed to its operation phase.

Figure 4.9 illustrates in more detail the conceptual architecture of the negotiation environment, also representing the involved actors and basic support modules.

In order that the negotiation environment can be properly implemented and suitable partners can be chosen, it is necessary that it has access to the VBE management system, mainly to the VBE Members' profiles, competences, value systems, and level of trustworthiness, as well as access to their collaboration history.

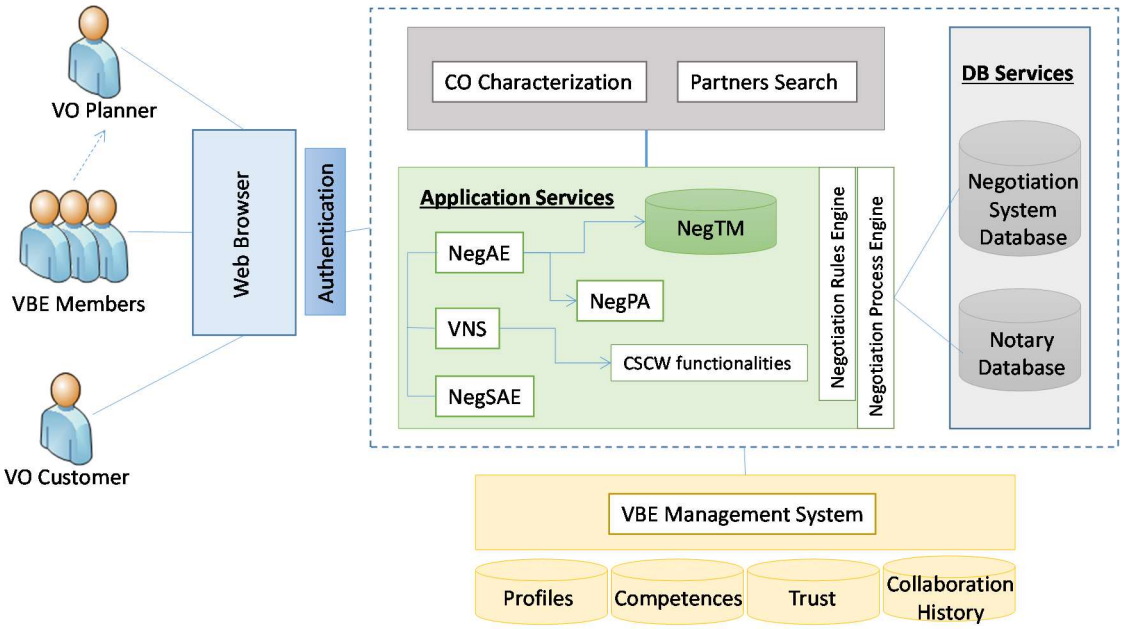

Figure 4.9. Conceptual architecture of the WizAN negotiation environment

The agreement negotiation wizard (WizAN), was developed comprising five main functionalities: negotiation agreement editor (NegAE); negotiating partners' risk assessment (NegPA); virtual negotiation spaces management (VNS); negotiation template management (NegTM); and negotiation support for agreement establishment (NegSAE). The description of those functionalities is summarized in Table 4.7.

Table 4.7. Basic modules of the WizAN negotiation support environment.

Description
Negotiation Agreement Editor (NegAE). This module is the main point of interaction with the user, allowing the initiation, conduction and monitoring of the entire negotiation process in VO creation. This module uses a selected template in the NegTM module and agreed negotiation topics to add new clauses to the agreement. The main users are the VO planner and the potential partners (Oliveira, et al., 2010).
Negotiating Partners' Risk Assessment (NegPA). This module, through interaction with the VBE management system, provides an assessment of the value systems and levels of trustworthiness of potential partners to forecast potential risks for collaboration.
Virtual Negotiation Spaces Management (VNS). This module handles the virtual spaces where the potential partners of the VO are invited to join in order to negotiate and/or discuss to reach agreements on the necessary topics/clauses (Oliveira, et al., 2010).

Negotiation Templates Management (NegTM). This module manages a collection of agreement templates and negotiation topic templates to support the negotiation in VO creation. It is also possible to build or edit new agreement skeletons or templates and add them to the collection.
Negotiation Support for Agreement Establishment (NegSAE). This module enables the interaction with the e-Notary system providing VO partners with mechanisms for digitally signing documents.

Taking into consideration the main requirements of the negotiation support environment as well as the identified functionalities, Figure 4.10 illustrates the strategic dependency model for the negotiation steps in VO creation where the main dependences between actors and system functionalities are represented.

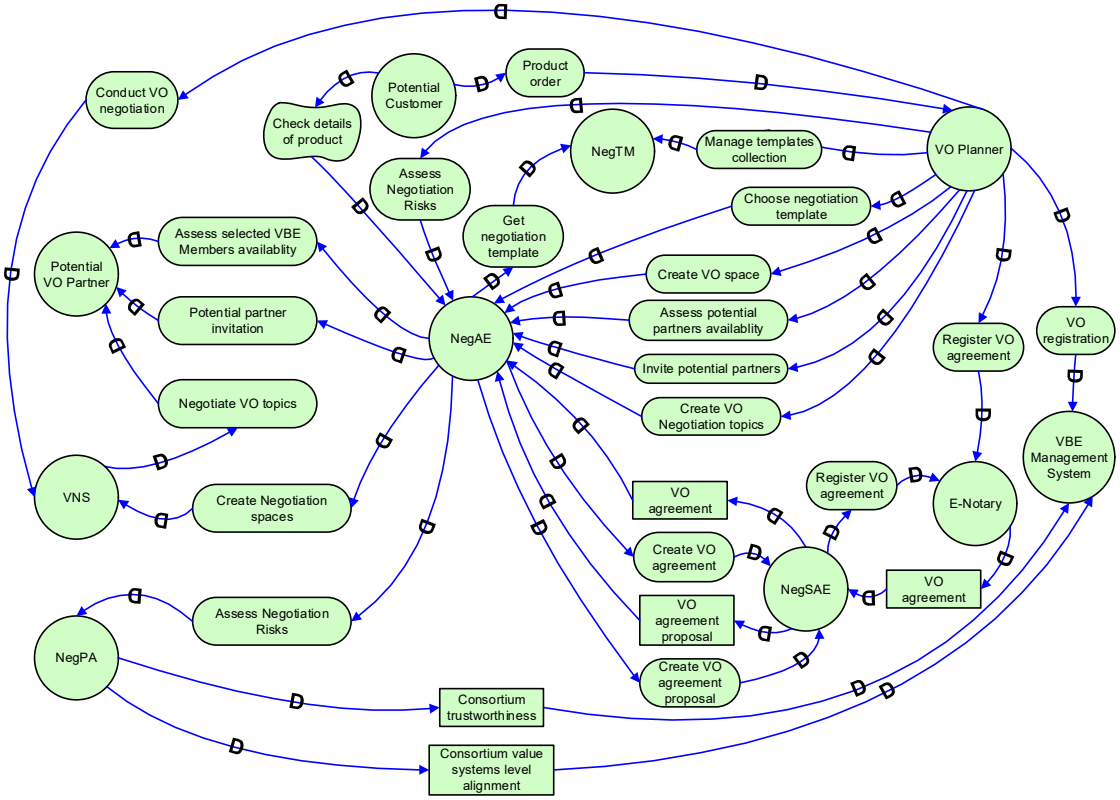

Figure 4.10. Strategic dependency model for the WizAN negotiation support environment

As examples of such dependencies, in the beginning of the negotiation process, the VO planner has the goal of creating a VO space, that is dependent from the NegAE module. Then several other goals exist along the negotiation process such as to *assess potential partners' availability*, *invite potential partners*, etc. The negotiation process ends with the *VO registration* goal that is a dependency of the VO planner from the VBE management system.

A more detailed description of the various modules of WizAN follows.

4.4.1 Negotiation Agreement Editor

The negotiation agreement editor (NegAE), is the main point of interaction with the VO negotiation support environment. Through NegAE multiple-users can find the base information regarding the agreements being established among the potential VO partners. The main users are the VO planner, the customer, and the potential partners.

As the NegAE concerns the general part of the agreement that is being established, it allows the VO planner to initiate, conduct, and monitor the VO creation. For this purpose, NegAE considers four distinct levels of information elements: *General Information; Supporting Documents*; *Negotiation Spaces*; and *Commitment to Agreement*, as illustrated in Figure 4.11.

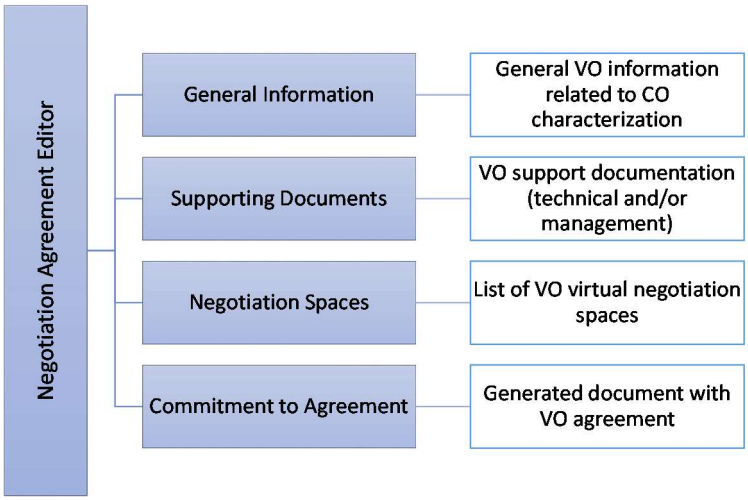

Figure 4.11. NegAE information entities

As the VO planner is the one that initiates the VO creation process, he/she is allowed to:

- Delete a selected VO collaboration space;
- Manage a selected VO collaboration space, where the information related to the VO is presented, namely, the general information, the documents that give support to the VO, the negotiation spaces that are created and finally, the corresponding agreement document associated to the VO.
  - To manage the ***General Information*** element, the VO planner is able to:
    - Manage *VO Details* that consist on the name and description of the VO, the customer, the economic sector, the starting date, among others. As the VO

planner is the initiator of the VO, he/she can also change details and save them;

- Choose the *Potential Consortium* for the VO. For that, the VO planner has access to a list of suitable potential consortia considering the VO requirements. To assist the user in choosing the most adequate consortium, the NegAE can provide a ranking of the consortia list according to the consortium's value systems alignment and level of trustworthiness (making use of the negotiating partners' risk assessment module (NegPA)). According to this ranking and to personal preferences, the VO planner is then able to decide on the final consortium for the VO;
- Manage the *VO Potential Partners*, to add, remove and/or replace potential participants in the VO. These changes can occur considering the course of negotiations as well as based on personal preferences being the universe, from where the VO planner can choose new potential partners, the VBE or the customer related community (as described in section 3.1.3);

- To manage the VO ***Supporting Documents***, the VO planner has access to a list of all documents that for some reason are important to the VO creation, as a schematic drawing with requirements of the new services. If necessary, the VO planner can also download, upload and delete documents. Each time a document is modified, the system keeps a record with document versioning control. Only the VO planner can delete/remove these attached documents;
- To manage the *Virtual* ***Negotiation Spaces***, the VO planner has access to a list of the existing virtual negotiation spaces (VNSs) of a VO, and can create, manage and delete individual VNS of negotiation topics;
- To manage the ***Agreement Commitment***, when all negotiations are closed and there is no need for further discussion, the VO planner can generate the document that represents a synthesis of the reached agreements. For that, he/she creates an agreement proposal document, that after being accepted by all involved partners, evolves to the final agreement and is stored in the electronic notary through the negotiation support for agreement establishment (NegSAEs) module.

Figure 4.12 summarizes the different flows of interaction that the VO planner may have with NegAE.

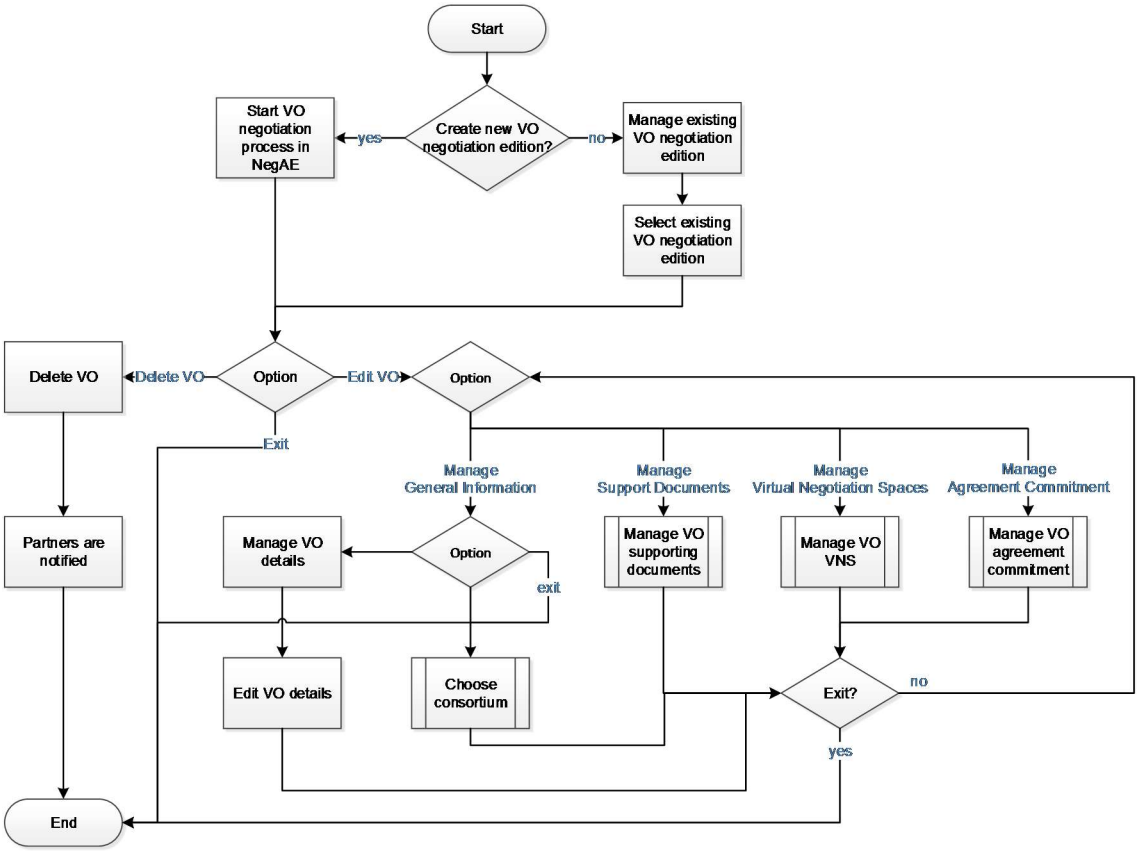

Figure 4.12. Interaction flow of VO planner with NegAE

Considering that, the negotiation support environment is a multi-user environment and that different roles might have different permissions / visibility access to the VO information, then different functionalities, according to user roles are available for the mentioned four information elements of the NegAE. Thus, VO potential partners (as well as the customer, if he/she participates in the VO creation) are able to:

— Participate in a VO collaboration space to which an invitation has been sent. For that, the information related to the VO should be available, namely, the general information, the documents that give support to the VO, the list of virtual negotiation spaces where the user is participating, and finally a functionality to accept the agreement document associated to the VO. In summary, the potential partner can:

- Verify the VO ***General Information***, including the name of the VO, the customer, the creation date, among others. Functionalities for accepting or rejecting participation in the VO are also available. In addition, the potential VO partner can access to a list of all other involved participants.

- Verify the ***Supporting Documents***, with access to all documents that are important for the VO creation. The potential VO partner can preview and download existing documents, but can also suggest new ones.
- Verify the *Virtual* ***Negotiation Spaces***, where all negotiation topics to which the VO partner is invited are listed and can be viewed. It is in this space that the potential partner can in fact propose and negotiate aspects that will have direct influence in the VO. VNSs where the potential partner has no participation are not listed.
- Verify the ***Agreement Commitment***, where if all the discussions are already closed and the VO planner has generated the VO agreement proposal, each partner may accept and sign it, with the assistance of the electronic notary and registry system.

Figure 4.13 shows the different flows of interaction that the potential VO partners may have with NegAE.

Considering the main relations of the negotiation agreement editor (NegAE), Figure 4.14 illustrates a partial view of the strategic rational model initially presented in Figure 4.10, but now highlighting the internal decomposition of the main goals and dependences of NegAE. The main tasks of NegAE to satisfy the goal dependencies among related actors and other modules of WiZAN are represented in this model.

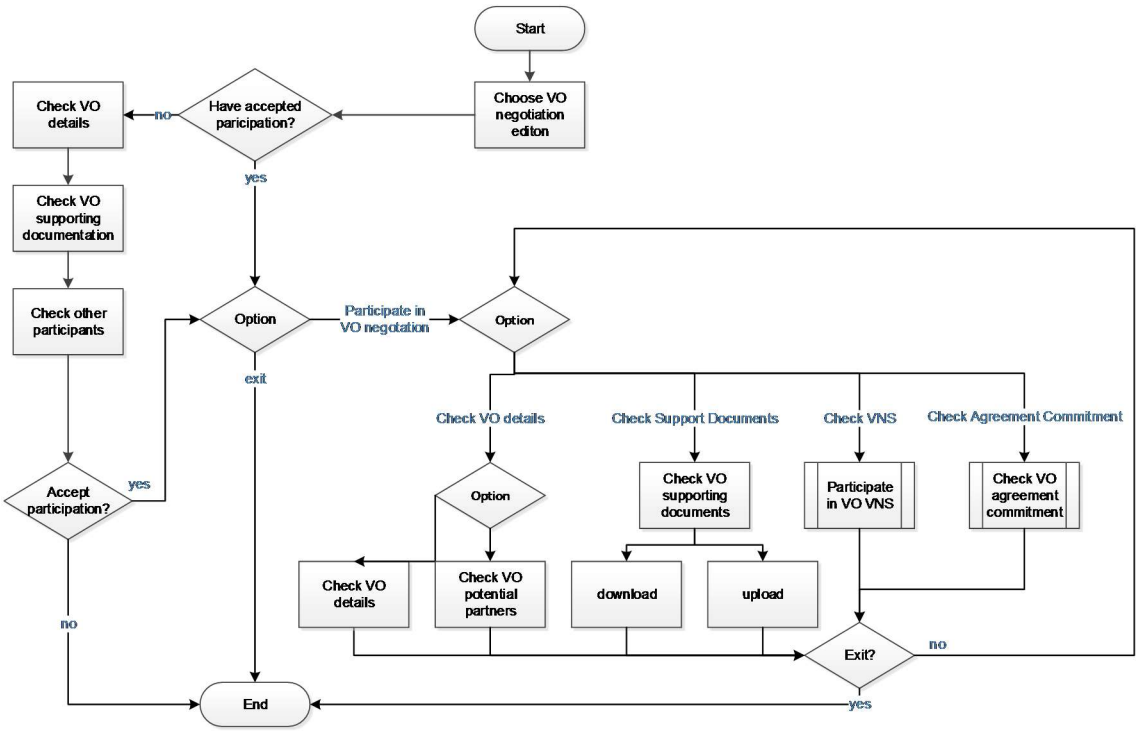

Figure 4.13. Interaction flow of VO potential partners with NegAE

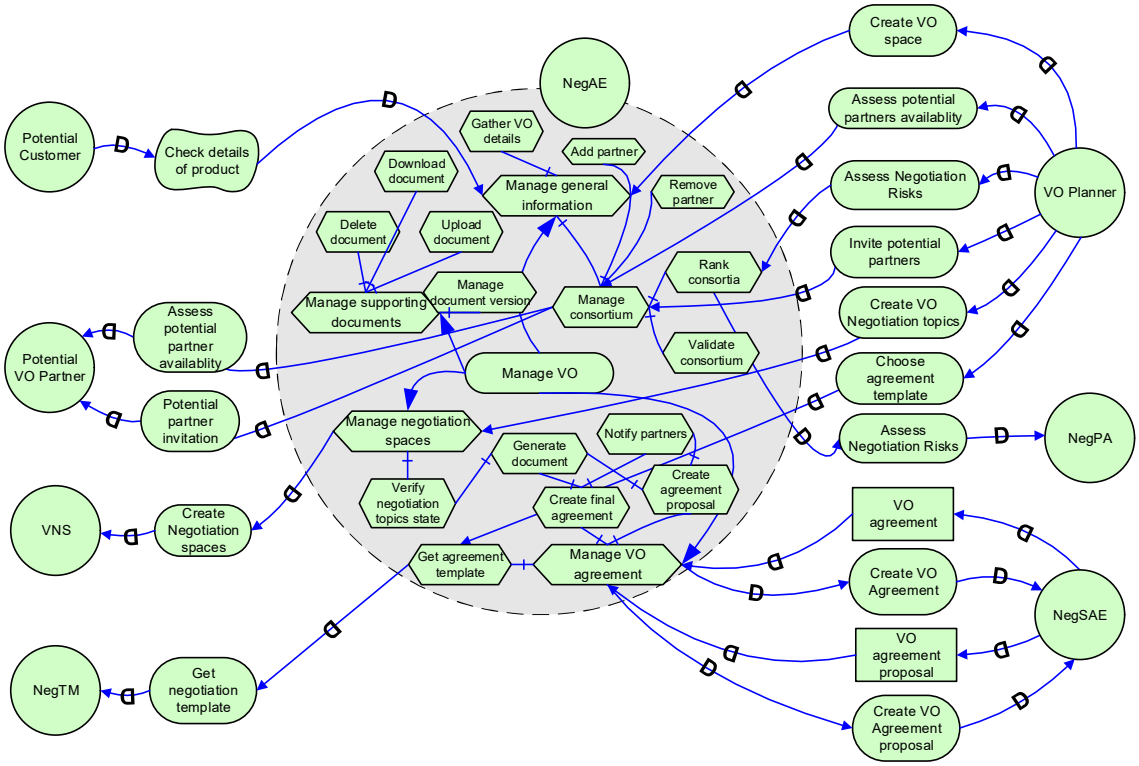

Figure 4.14. Strategic rational model for the negotiation support environment (Partial view – NegAE)

4.4.2 Negotiating Partners' Risk Assessment

Every VO has a certain level of associated risks, which can have different drivers and sources. Therefore, if the VO Planner can be assisted in forecasting the potential risk of a certain consortium, then the decision about the final consortium for the VO can be more accurate. In order to assess the risk level of a potential VO, the VO planner, through the NegAE, can make use of the negotiating partners' risk assessment module (NegPA). This functionality directly interacts with the VBE management functionalities to infer the value systems alignment level of a potential consortium (Macedo and Camarinha-Matos, 2013) and its level of trustworthiness considering the involved partners (Msanjila and Afsarmanesh, 2008a).

Based on these two indicators, the potential consortia for the corresponding VO are ranked accordingly. This filtering process contributes to reduce potential risks in the VO, assuming that a high level of mutual trust among partners and a good alignment of their value systems reduces the likelihood of conflicts.

Figure 4.15 shows an adapted i* Rationale Strategic model of the NegPA where the involved actors, as well as their dependency objectives, are illustrated. Within the

boundaries of the NegPA, the respective tasks and sub-tasks are presented. The tasks that directly interact with the involved actors and other related sub-systems are also depicted, as is the example of *rank consortia*, *assess consortium value system alignment level*, etc.

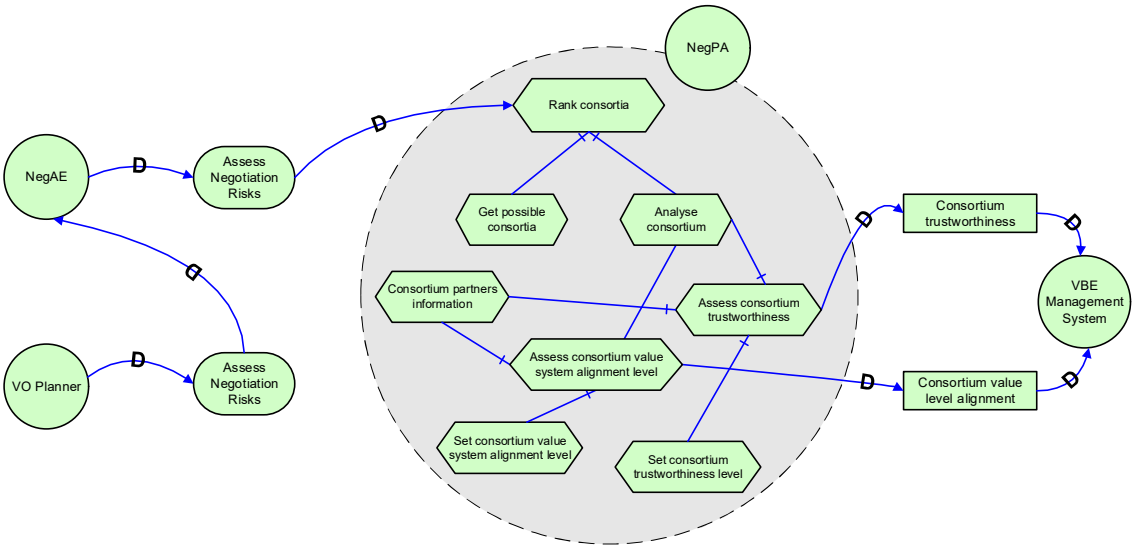

Figure 4.15. Strategic rational model for the negotiation support environment (Partial view – NegPA)

4.4.3 Virtual Negotiation Spaces Management

During a specific negotiation, only the involved parties shall have access to the corresponding exchanged information. Therefore, with the purpose of supporting this process, for each negotiation topic, a virtual negotiation space is created. It is through the utilization of VNSs that partners are able to privately discuss subjects that must be agreed. Only the involved partners shall be invited to take part in the discussion of each specific topic.

Each VNS can be divided into two distinct parts: one for edition of the negotiation topic characteristics and associated documents, and another for enabling discussion among the involved partners by means of chatting (enabling synchronous communication between participants) and/or specific forums that only the members of that VNS can have access to (asynchronous communication).

The **edition** part of a VNS is designed to provide functionalities for the VO planner such as:

- Edit general information, such as name, purpose, creation date, etc., for the specific negotiation topic;
- Add / remove/ replace partners to/from the virtual negotiation space, choosing from the partners already invited to the collaboration space of the VO (see Figure 4.3;
- Choose the topic agreement modality, as each topic might have a different agreement modality depending on what it concerns. The topics might be agreed by: unanimity (when all partners must agree), majority (when only the majority of partners have to agree), or informative (when there is no need for partners to agree);
- Add / read / edit documents that refer to the VNS;
- Open discussion area, to make the communication among partners more agile, providing functionalities of chat and forum. These functionalities enable the involved members to discuss subjects related to the negotiation topic that they are dealing with. Each time a user enters a VNS, he/she has access to the discussions around the topics he/she is involved in. As a way to provide confidentially, partners should not be allowed to view discussions about subjects in which they are not involved;
- Check partners commitment towards a VNS, to verify if partners have already reached consensus on a specific topic;
- Close VNS, once all agreements are reached on a specific topic, the VO planner can close it. After closing, the VNS is locked and contents cannot be changed;
- Delete topic when specific conditions occur, what may lead the VO planner to delete / cancel a negotiation topic.

Figure 4.16 illustrates the different flows of interaction that a VO planner may have with a VNS.

On the other hand, potential VO partners involved in the negotiation have some restrictions regarding the use of these functionalities, namely in what concerns: *Adding partners to the VNS*; *Editing associated documents*; and *General information management*.

Figure 4.17 illustrates the different flows of interaction that the potential VO partners may have with VNS.

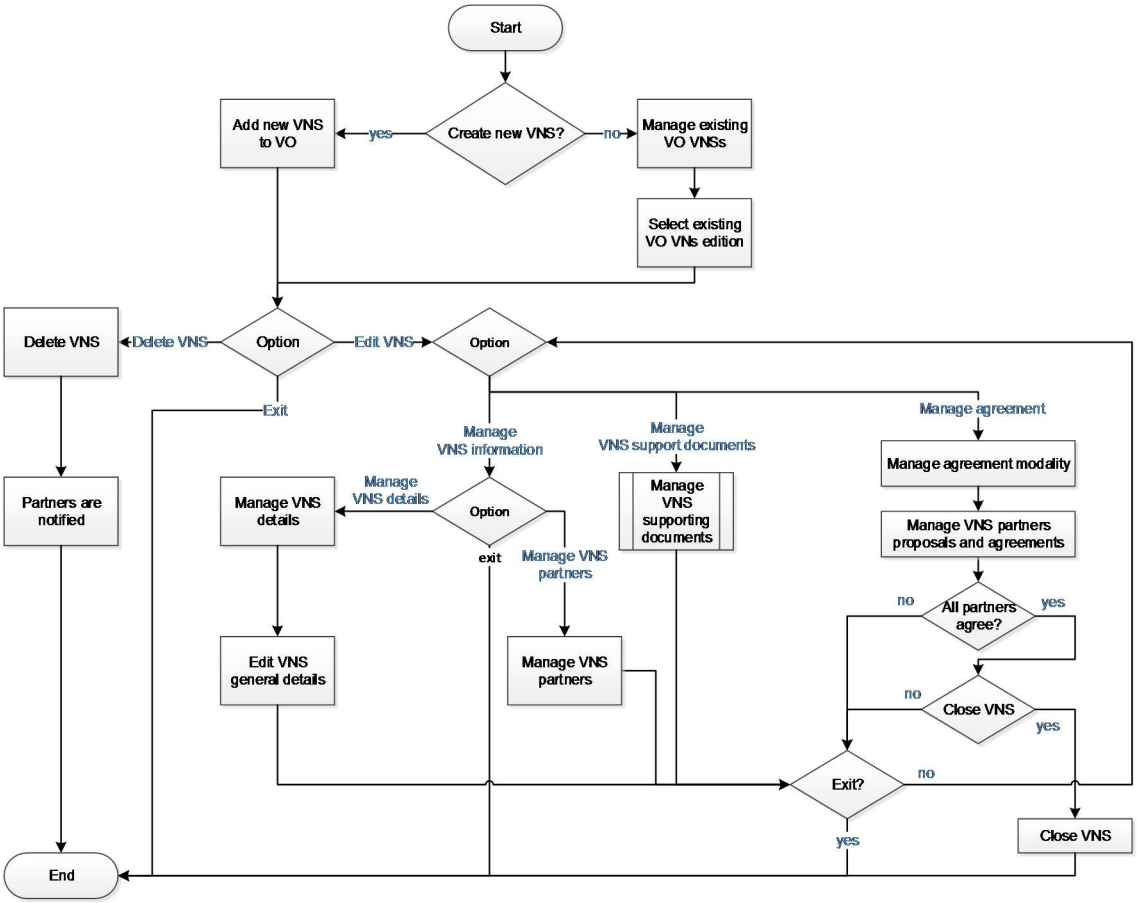

Figure 4.16. Interaction flow of VO planner with VNS

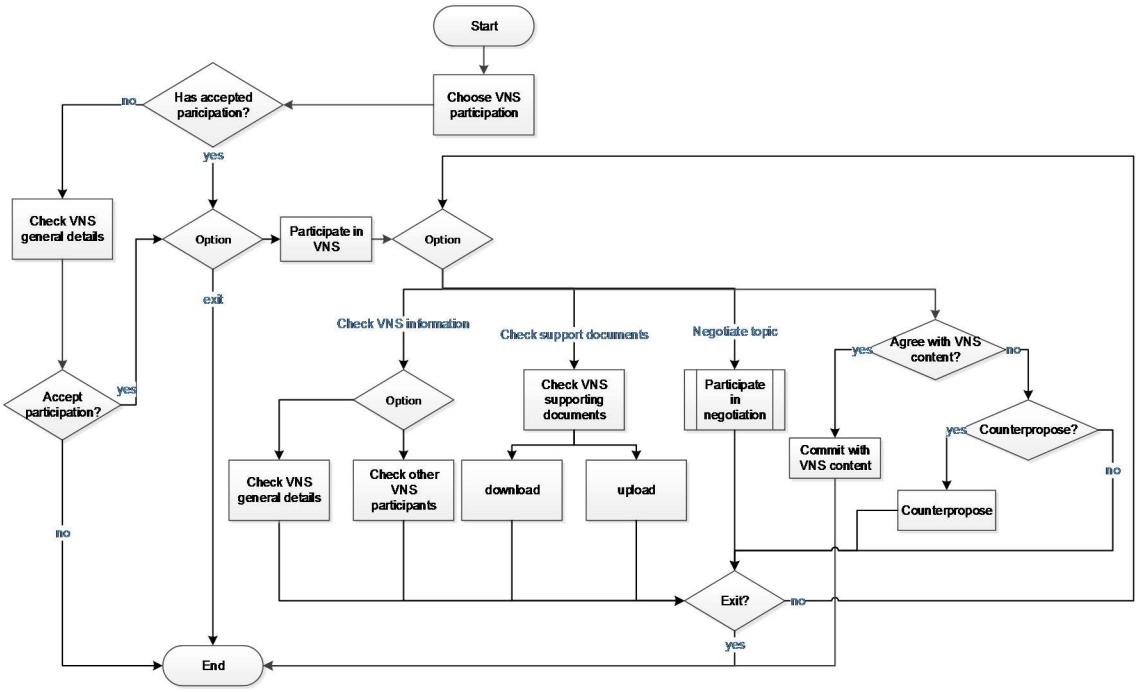

Figure 4.17. Interaction flow of VO potential partners with VNS

As the VO planner is the one responsible for VNS creation, whenever a potential partner requires a new negotiation topic, he/she can propose it to the VO planner through the discussion functionality. If the VO planner agrees with the proposal, he/she will initiate the VNS.

Considering the main relations of the virtual negotiation spaces, Figure 4.18 illustrates a partial view of the strategic dependency model initially presented in Figure 4.10, now highlighting the internal decomposition of the main goals and dependences of VNS. The represented goals mainly depend on the VNS task *manage VNS*. Depending on the purpose, this major task is then split into several sub-tasks, such as *manage VNs details*, *manage support documentation*, *close VNS*, etc.

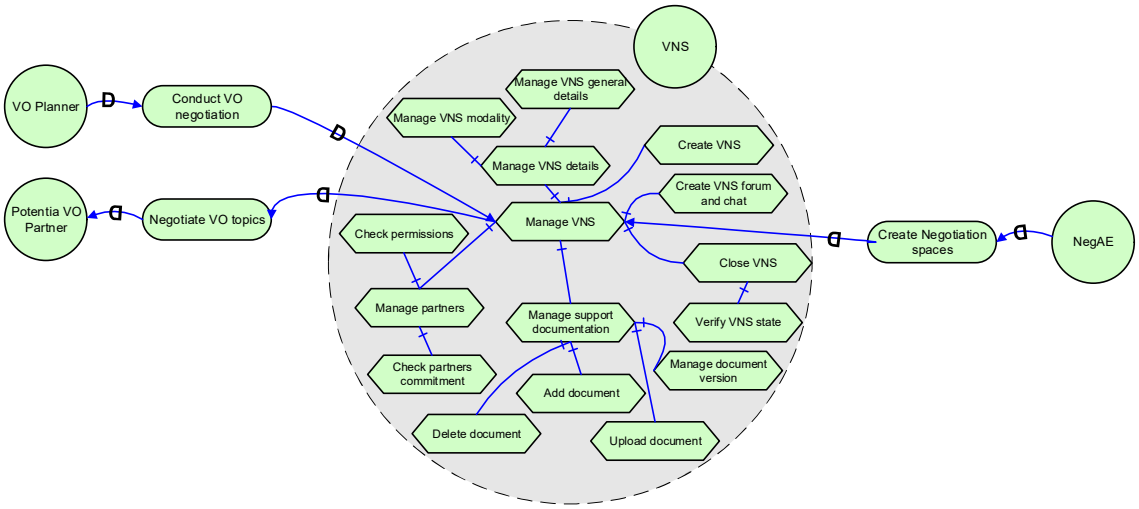

Figure 4.18. Strategic rational model for the negotiation support environment (Partial view – VNS)

4.4.4 Negotiation Templates Management

This module is intended to manage a collection of agreement templates and a list of pre-defined negotiation topic templates to support the VO creation. In the agreement construction process it is possible to build or edit new agreement skeletons or templates and add them to the collection.

The proposed *agreement template* is composed of several *sections*, and each section may have as many *fields* as required. Figure 4.19 illustrates the structure of an agreement template with some sections and the corresponding fields. On the right hand side of the figure, it is exemplified how the structure can be represented in a human readable document. The negotiation template management (NegTM) module allows its users to create and/or edit existing agreement templates. With this module, the VO planner can instantiate a suitable agreement template to generate the VO agreement.

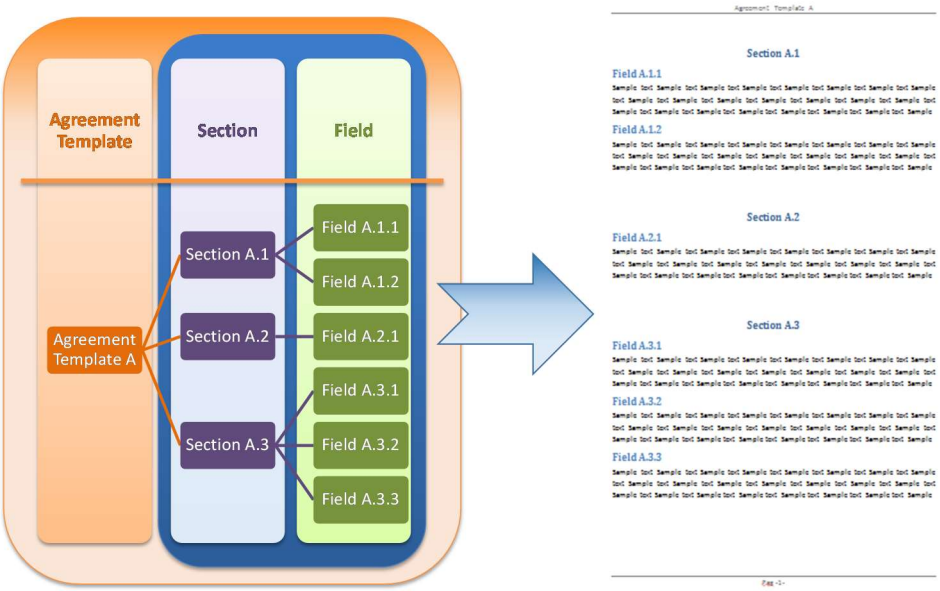

Figure 4.19. Example of agreement template structure (sections and fields)

Considering the main relations of the negotiation templates management (NegTM), Figure 4.20 illustrates a partial view of the strategic dependency model initially presented in Figure 4.10, now highlighting the internal decomposition of the main goals and dependences of NegTM, focusing on the interactions with the VO planner. In this figure the main tasks and sub-tasks such as *agreement templates management*, *section templates management*, *field templates management*, etc. are represented.

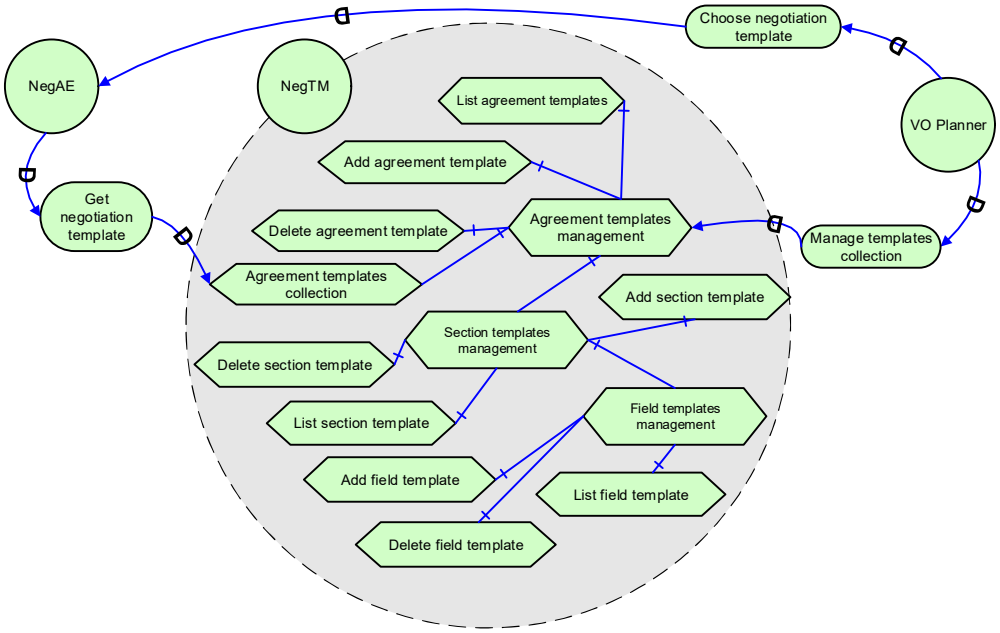

Figure 4.20. Strategic rational model for the negotiation support environment (Partial view – NegTM)

4.4.5 Negotiation Support for Agreement Establishment

The negotiation support for agreement establishment (NegSAE) module is responsible for the direct interaction of the negotiation agreement editor (NegAE) with the electronic notary and registry system (e-Notary). To create the final VO agreement document and store it on the e-Notary, the NegSAE should enable the VO planner to create an agreement proposal only after ensuring that all virtual negotiation spaces are closed and no more negotiation rounds are required to finish the VO creation process. In this case, the agreement proposal can be created and made available to all VO partners so that they can verify and accept it. Only after this procedure, the VO planner, through NegSAE, can generate the final agreement, which is automatically sent to e-Notary (already signed by the VO planner). In the e-Notary, a corresponding *negotiation dossier* is created with the VO agreement and all other VO support documentation. All VO partners are then notified to digitally sign the VO agreement through the e-Notary system. Figure 4.21 illustrates the flow of interaction that the VO planner has with NegSAE module.

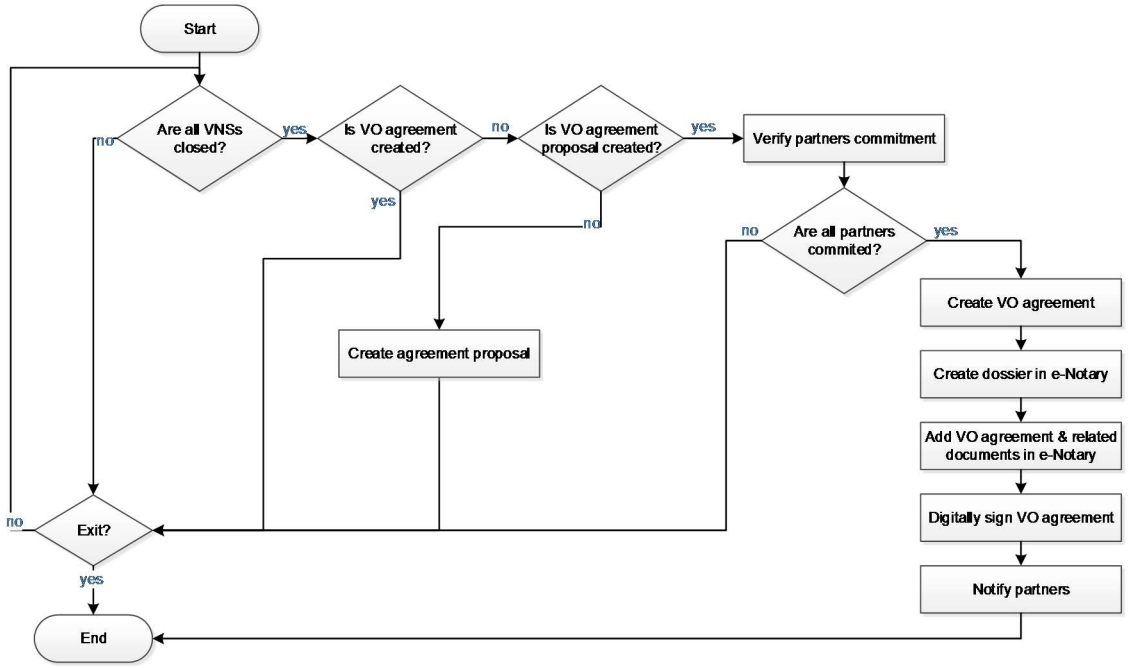

Figure 4.21. Interaction flow of VO planner with NegSAE

Figure 4.22 illustrates the flow of interactions between the VO partners and the NegSAE module.

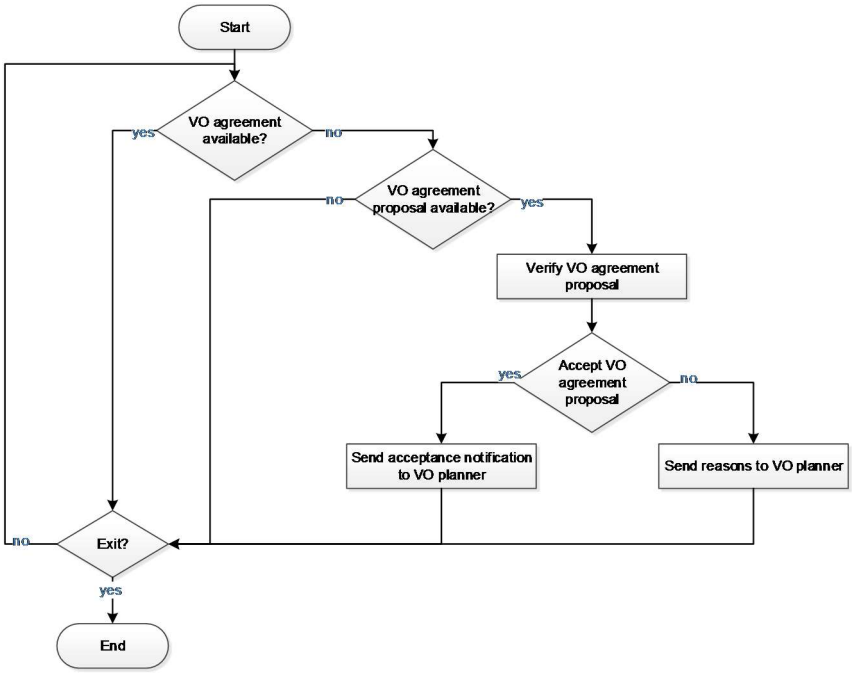

Figure 4.22. Interaction flow of potential VO partners with NegSAE

Considering the main relations of the negotiation support for agreement establishment, Figure 4.23 illustrates a partial view of the strategic dependency model initially presented in Figure 4.10, now highlighting the internal decomposition of the main goals and dependences of NegSAE. The main tasks and sub-tasks such as *create VO agreement*, *check partners commitments to VO agreement proposal*, *register VO agreement*, etc. are represented in this figure.

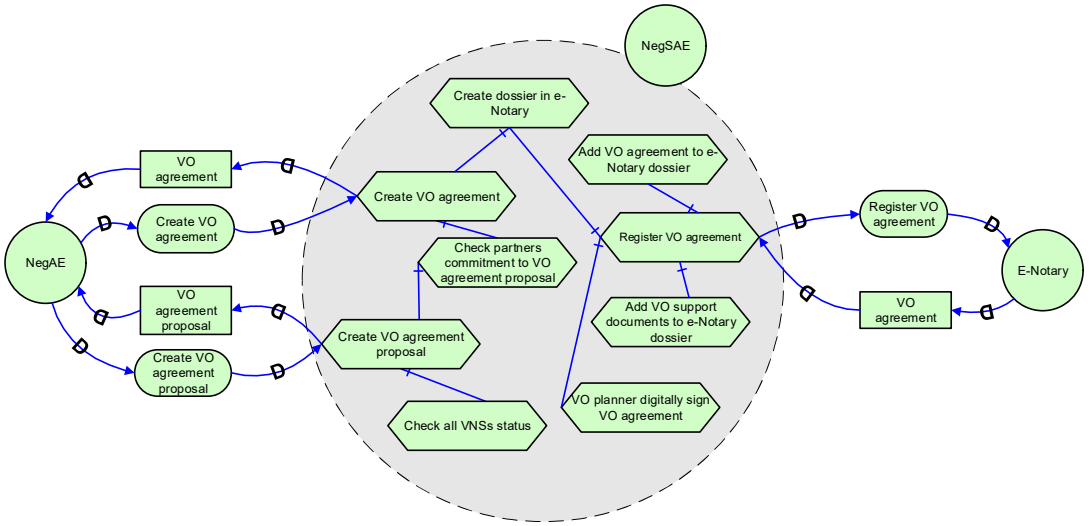

Figure 4.23. Strategic rational model for the negotiation support environment (Partial view – NegSAE)

4.5 Negotiation Support Environment for Service Co-Design

Due to the increasing demand from customers for highly customized products, one tendency for manufacturers is to associate business services (BS) to the products they offer (Baines et al., 2007; Camarinha-Matos et al., 2012b). From a collaborative perspective, these services are designed and created by multiple stakeholders to meet the individual customer needs and/or requirements. Here the interaction with the customer and local suppliers is fundamental and leads to the notion of co-creation / co-design of business services in a service co-creation network (Camarinha-Matos, et al., 2013b).

Definition 7. Co-creation network

A co-creation network aims to co-design innovative value-added services for products when new promising business ideas emerge or an additional need is detected. This network is based on collaboration between manufacturers, customers, and members of the customers 'community.

The co-creation network shall be supported by a collaboration environment that helps in the design and provision of business services based on innovation, knowledge, and customer orientation. Through the collaboration among the different stakeholders (manufacturers, customer, and members of the customer's community - open innovation approach (Chesbrough et al., 2006)), this network should also support the identification of future needs. When designing new business services, it can be assumed that there is a consortium of interested stakeholders (acting like a VO) with the aim of reaching agreements on the design requirements of the new business service. Therefore, the same negotiation support environment used for VO creation, can contribute to boost the stakeholders participation in the business service design, namely if the decision making process is fundamentally made by human actors (Oliveira, et al., 2010; Oliveira and Camarinha-Matos, 2012, 2013). Similar to the negotiation support environment for VO creation (WizAN), the services co-design negotiation environment (CoDeN) (Oliveira and Camarinha-Matos, 2014a) is also intended to facilitate the generation of an agreement that represents the consensus reached on the characteristics of a new business service. However, in this case there are no free negotiation topics. Instead, the consensus that has to be reached is guided by an adopted *service design methodology* (Mager and Sung, 2011; Oliveira and Camarinha-Matos, 2014b, 2014a) that serves as a guide for the

negotiation. Figure 4.24 illustrates the usability of the services co-design negotiation environment.

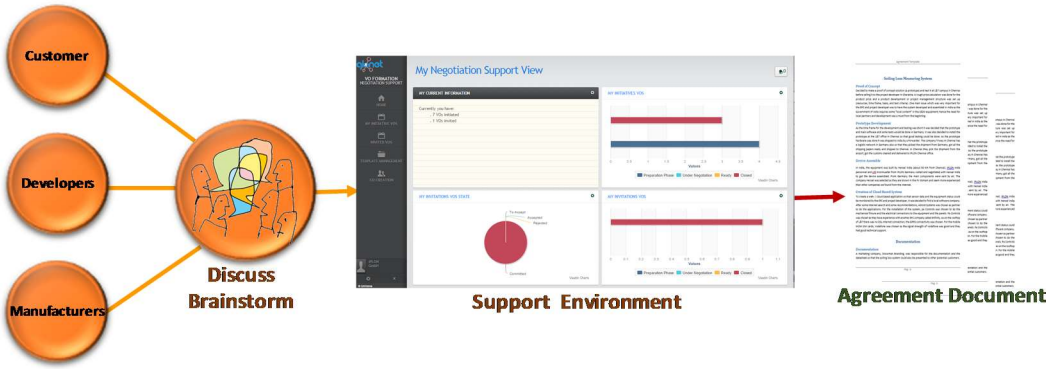

Figure 4.24. Usability of the services co-design negotiation environment

4.5.1 Actors and their Dependencies in BS Co-Design

In order to facilitate the co-creation process, the services co-design negotiation environment (CoDeN) is proposed (Oliveira and Camarinha-Matos, 2014a) as a multi-stakeholders collaborative environment. The involved participants in this process (including the customer) are initially selected by the initiator of the co-creation process. Besides the important roles of customer and involved participants (forming a co-creation team), also the role of *co-creation team mediator* is introduced to conduct the entire negotiation process (acting like the VO planner for the creation of new VOs). Therefore, to properly model the core processes involved in co-creation business scenario, the main actors with the corresponding roles are identified in Table 4.8. The dependencies between them, such as *service co-creation*, *mediate negotiation*, *negotiate business service design*, etc., are shown in Figure 4.25, using the strategic dependency model.

Table 4.8. Actors and roles in co-creation

Actor	*Role*
Co-creation team	The Co-creation team represents all involved actors within the collaborative space aimed for co-designing new services.
Co-creation team mediator	The co-creation team mediator is the VO partner responsible to conduct the entire co-design negotiation process.
VO partners	VBE member that is part of the co-creation team, and gives support to the service co-design with corresponding knowledge and skills.
Customer	The customer is also part of the co-creation team, and together with the VO partners plays an important role in the service co-design since his/her satisfaction must be attained. He/she may be also responsible for providing the requirements and for giving feedback during the collaboration processes.

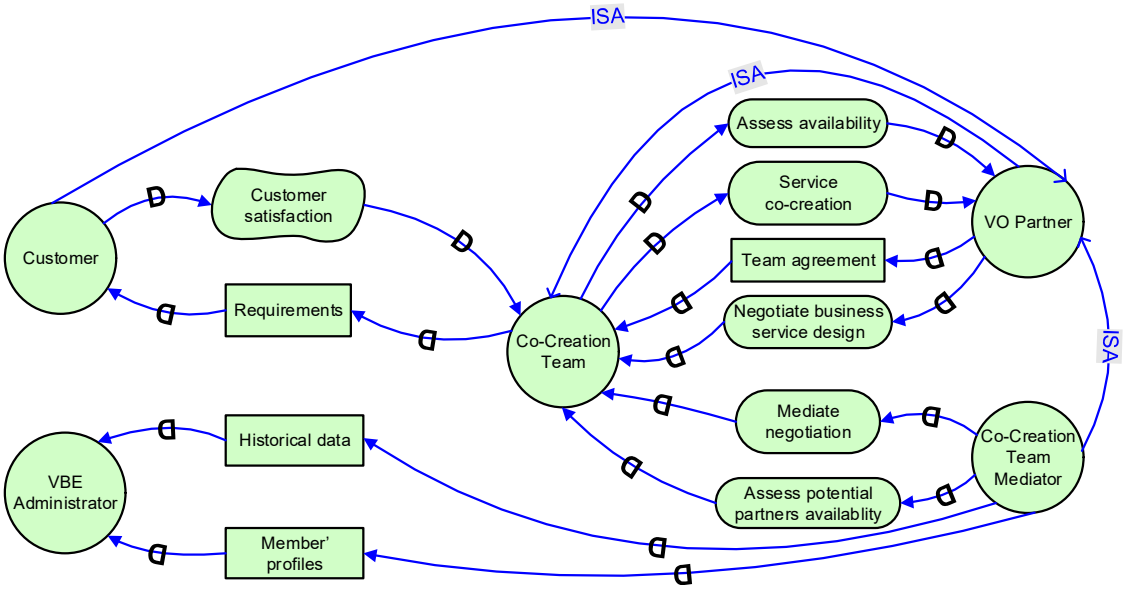

Figure 4.25. Strategic dependency model for co-creation

Figure 4.26 and Figure 4.27 clarify the internal dependencies of the involved actors with strategic rational models representing the actors' tasks and sub-tasks.

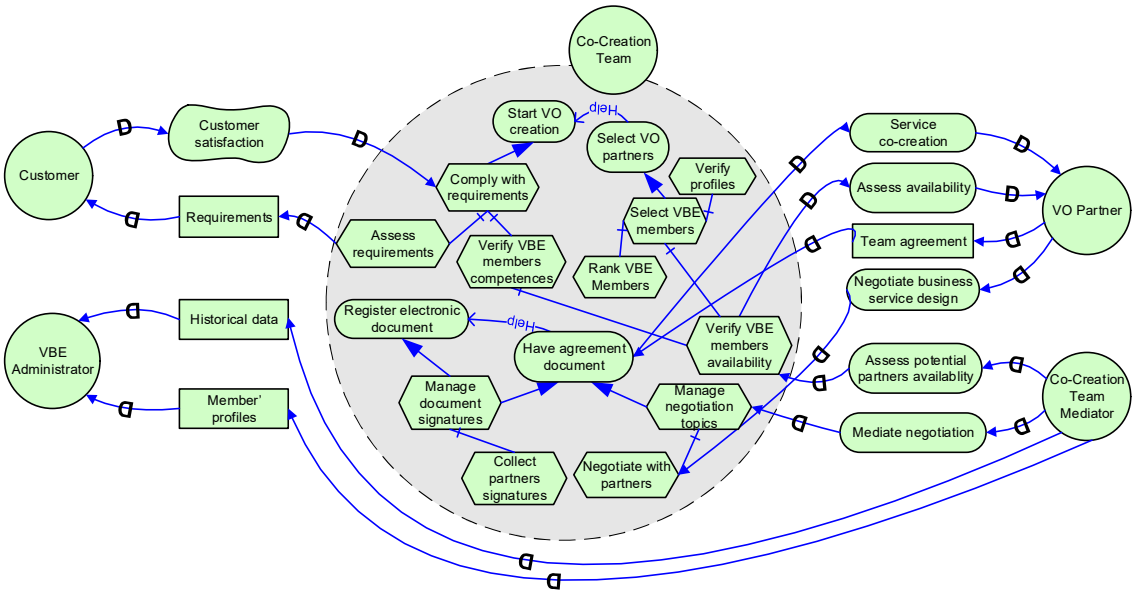

Figure 4.26. Strategic rational model for co-creation (partial view – co-creation team)

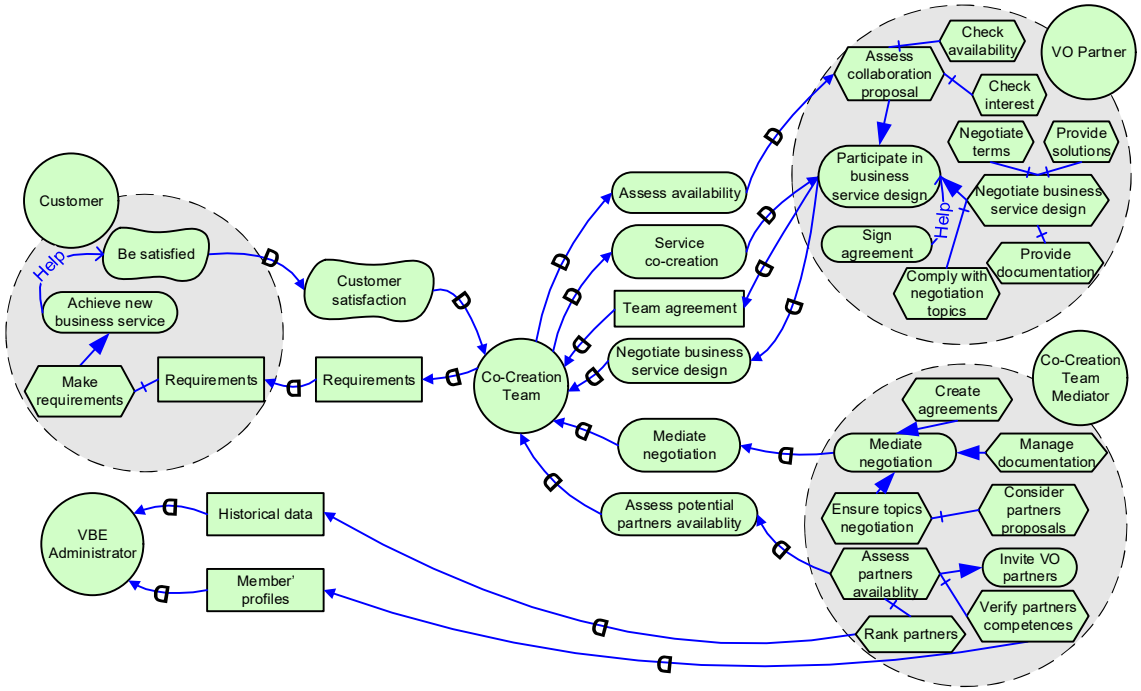

Figure 4.27. Strategic rational model for co-creation (partial view – VO partners)

The business service co-design process is conducted by a co-creation team mediator and can be initiated when a new innovation or requirement is identified, typically, by the customer. Figure 4.28 represents the business service co-design process being initiated by the co-creation team.

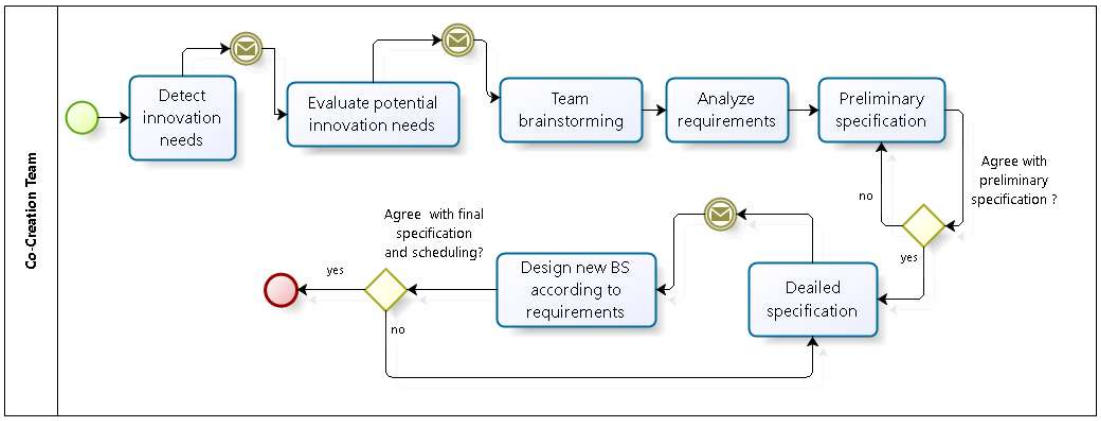

Figure 4.28. Co-design process diagram

4.5.2 Adopted Service Design Methodology

A number of methods and tools for service design can be found in different disciplines and for different purposes (Wild, 2009). Nevertheless, most of the tools are simply manual methods to organize collaboration processes that typically follow a non-structured approach. Some examples of available service design templates can be found in Annex B.

The proposed solution aims to use methodological practices from the service design discipline (Mager and Sung, 2011) and adapt it to a philosophy of co-design where new business services can be designed following a structured approach in a collaborative environment with multi-stakeholders, including the customer involvement (Oliveira and Camarinha-Matos, 2014a).

The proposed methodology identifies and defines the needed services, their interactions with the customer, and their nature. The methodology is summarized in Table 4.9.

Besides the service design steps, it is also important to identify: *(i)* who are the participants; *(ii)* the touchpoints with the customer; and *(iii)* how the participants can share information and documentation. Table 4.10 summarizes the relevant characteristics of service design and their relevance for co-creation teams.

Table 4.9. Service design methodology

Service Design steps	*Description*
1. Identify needed service	Brainstorming exercise involving an analysis of the needs and characteristics of the customer.
2. Design touchpoints diagram	To identify the user interaction points with the service.
3. Design blueprint diagram	To describe the nature and the characteristics of the service interaction to verify, implement, and maintain it. It includes: temporal order, timings, and line of visibility (denoting what the customer sees and *back-office*).
4. Storyboard / storytelling	Representation of use cases, through a series of drawings or textual description put together in a narrative sequence, which illustrates a sequence of events such as a customer journey.
5. Service prototyping	Involving the selection, assembly and integration of the various service components.

Table 4.10. Service design methodology in co-creation teams

	Service Design characteristics	*Relevance for co-creation teams*
Participants	Service design assumes the involvement of various participants from different backgrounds and specially the interaction with the customer.	Co-creation of a new service is expected to involve a temporary collaborative network, including different stakeholders, such as geographically dispersed manufacturers, and providers and supporting institutions close to the customer. The customer is also an active part.
TouchPoints	In service design it is particularly relevant to identify the customer journey in the process of receiving the service, and thus the points of interaction with the service provider.	Aiming user-centered services and being the customer an active part of co-design, it is very important to consider his/her interactions with the service, namely the moments and places in which direct contact with the service exists.
Sharing	In service design methods, even if not supported by software tools, a shared space where all participants can visualize the progression of the design process is assumed.	Existence of a collaborative environment where the involved participants can interact in the design and creation processes and reaching agreements.

Considering all the above, the templates that are used in the CoDeN environment are described in Table 4.11.

Table 4.11. Used templates in CoDeN

Template		*Description*
Stakeholders mapping		Identifying the relevant stakeholders that are considered for direct and indirect contact with the new business service.
Service blueprint diagrams	User	Highlighting what the customer of the new business service does.
	Touchpoints	Identifying the moments and places when the customer gets into direct contact with the new business service.
	Service direct contact and Service back office	Identifying what should be the behaviour of the new business service.
	Means and processes	Identifying what else can be involved with the new business service delivery.

Each of the blueprints contains five areas for discussion that will guide negotiation:

— *Attract Attention:* How to create awareness and attract attention for service;

— *Inform:* How to stimulate the customer to take action;

— *Use:* How to respond to customer needs with regard to service provision;

— *Support:* How to handle problems or questions during service provision; and

— *Maintain:* How to enter into a relationship with the customer.

4.5.3 CoDeN Support Environment

As mentioned, the Services Co-Design Negotiation Support (CoDeN) environment is designed to provide a collaborative environment for the design of new business services where the various involved human participants can reach agreements on what is decided. In this process, the involved participants (including the customer) are defined from the beginning. Similar to a negotiation support environment for VO creation (Oliveira and Camarinha-Matos, 2008; Oliveira and Camarinha-Matos, 2012), CoDeN is also intended to cope with the requirements mentioned in WizAN in section 4.4 and generate an agreement that represents the reached consensus. Nevertheless, in this case, the consensus is reached based on a service design methodology that serves as a guide for the negotiation.

Figure 4.29 illustrates the main flow of the negotiation steps considering the first three steps of the service design methodology summarized in Table 4.9: *identify needed service*; *design touchpoint diagram*; and *design blueprint diagram*. The remaining two steps are not covered, since no negotiation is foreseen for them. Table 4.12 describes these main interactions.

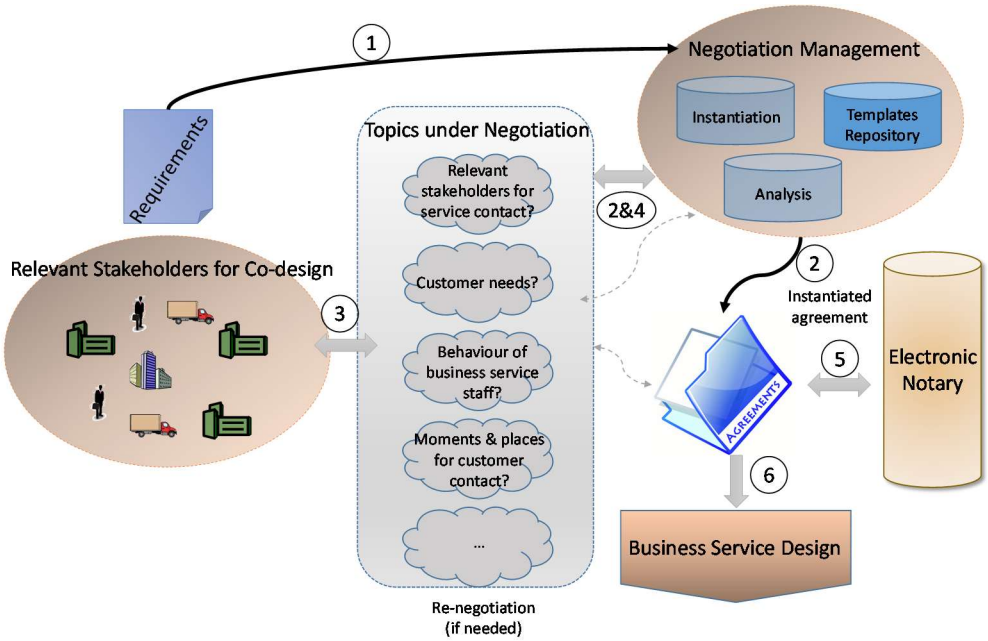

Figure 4.29. CoDeN usage scenario illustration

Table 4.12. Description of CoDeN usage scenario illustration

Step	*Description*
1	When an innovative business service idea appears, it is necessary to detail its main requirements. That information is essential to conduct the rest of the negotiation. The co-creation team mediator shall then initiate the negotiation process.
2	With this information the co-creation team mediator can include the general aspects of the business service to be co-designed. Through the CoDeN environment, the co-creation team mediator can also instantiate the service design templates for the upcoming negotiation.
3	In parallel with the instantiation of templates, the co-creation team mediator invites the partners that are most suitable for the new business service co-design. Supported by VBE management functionalities, the co-creation team mediator can assess the partners considering their competences, performance indicators, and/or other selection criteria.
4	Several rounds of negotiation may be necessary to achieve consensus on the service co-design templates content.
5	Compilation of the agreed negotiation templates content in the consortium agreement. The co-design agreement is the "assemblage" of information that was agreed by the involved participants in the negotiation templates. This information is divided into several sections according to their categories. For example, there is a section related to the partners involved in the business service design; a section related to each service design template; etc. At this point, tools to support the writing of documents, as well as e-Notary functions are used.
6	Agreement document with reached consensus signed by all involved partners in business service co-design.

Although the negotiation characteristics are quite similar to the VO creation negotiation support environment, Figure 4.30 illustrates in more detail the conceptual architecture of the CoDeN environment, also representing the central actors and basic support modules.

The interaction with the VBE information system is mainly to assess the VBE members' profile, competences, value system, and level of trustworthiness, as well as access to collaboration history, so that suitable partners can be invited to co-design of BS.

For the identified requirements, the proposed business service co-design negotiation environment, includes three main modules: *service design agreement editor* (SDAE); *negotiating partners' risk assessment* (NegPA); and n*egotiation support for agreement establishment* (NegSAE). On one hand, the modules: NegPA and NegSAE are reused from the VO creation negotiation environment, and on the other hand, the service design

agreement editor (SDAE) is the main point of interaction with the user, allowing the initiation, conduction and monitoring of the entire business service co-design negotiation process. The users of this module are the stakeholders involved in the co-design process.

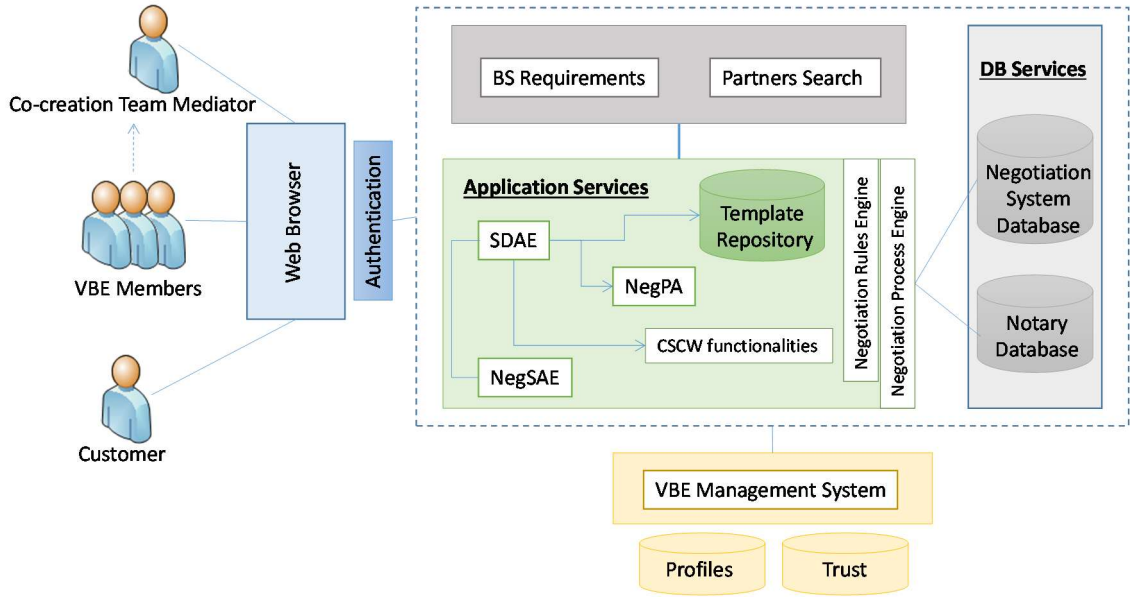

Figure 4.30. Conceptual architecture of the co-design negotiation environment

Taking into consideration the main requirements of the negotiation support environment as well as the identified functionalities, Figure 4.31 illustrates the strategic dependency model for the negotiation of a business service co-design where the main dependences between actors and system functionalities are represented.

As examples of such dependencies, in the beginning of the negotiation process, the co-creation team mediator has the goal to *initiate co-design negotiation,* that is dependent from the SDAE module. Then several other goals exist along the negotiation process, such as to *assess partner's availability, invite participants*, *manage design templates*, etc. The negotiation process ends with the *create BS co-design agreement* goal, that is a dependency of the co-creation team mediator from the NegSAE module.

As mentioned above, the main outcome of CoDeN is an agreement document, summarizing the results of the negotiations / discussions that were performed during the business service co-design process.

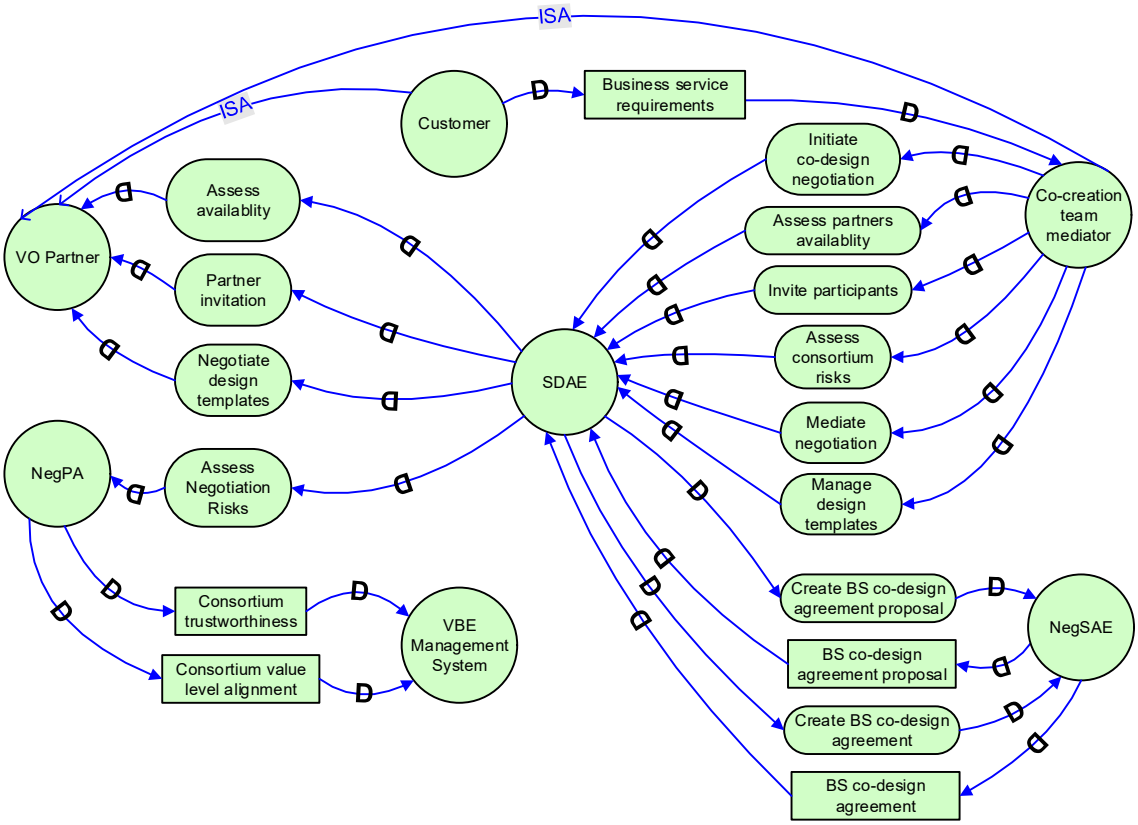

Figure 4.31. Strategic dependency model for the co-design negotiation support environment

4.5.3.1 Service Design Agreement Editor

Through the service design agreement editor (SDAE), the multiple-stakeholders can have direct access to the base information regarding the agreements being established among the co-creation team: co-creation team mediator, customer, and VO partners. With SDAE, the co-creation team mediator can initiate, conduct and monitor the entire business service co-design negotiation process. Thus, SDAE provides four distinct levels of information entities: *General Information; Supporting Documents*; *Co-Design Templates*; and *Commitment to Agreement*, as illustrated in Figure 4.32.

The co-creation team mediator is the one that initiates the creation process of the business service co-design, then is allowed to:

- Delete a selected business service co-design collaboration space;
- Manage a selected business service co-design collaboration space, where the information related to the business service co-design is presented, namely, the general information, the documents that give support to the business service co-design, the negotiation of the co-design templates and finally, the corresponding agreement document associated to the business service co-design.
  - To manage the ***General Information***, the co-creation team mediator is able to:

- Manage *Co-Creation Details* that includes the name and description of the business service being co-designed, the customer, economic sector, the starting date, among others. As the co-creation team mediator is the initiator of this process, it is also possible to change details and save them;
- Choose the *Co-Creation Members* for the business service co-design. For this purpose, the co-creation team mediator has access to a list of VBE members from where members to form the co-creation consortium can be chosen. To assist in the selection of the most adequate partners for the consortium, SDAE generates the level of the consortium's value systems alignment and level of trustworthiness (making use of the negotiating partners' risk assessment module (NegPA));
- *Manage Co-creation team Members*, to add, remove and/or replace VO partners. These changes can occur considering the course of negotiations as well as personal preferences, being the universe from where the co-creation team mediator can choose new partners the VBE or the customer related community (as described in section 3.1.3).

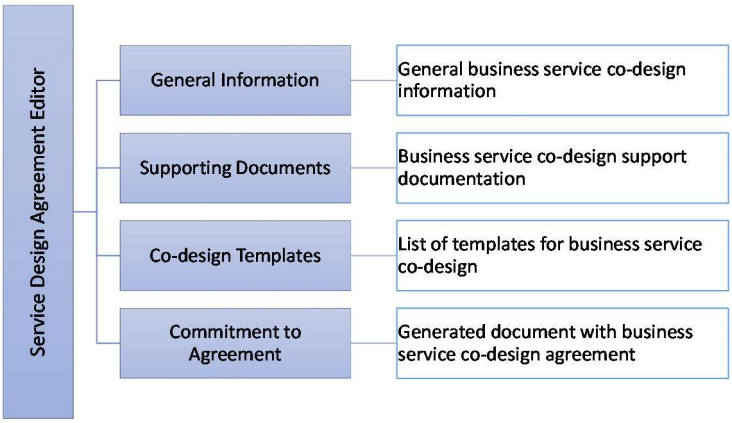

Figure 4.32. SDAE information entities

- To manage the co-design negotiation Supporting Documents, the co-creation team mediator can have access to a list of all relevant documents for the business service co-creation negotiation. If necessary, the co-creation team mediator can also download, upload and delete documents. Each time a document is modified, the system keeps a record with document versioning;
- To manage the Co-Creation Templates, the co-creation team mediator has access to the list of co-design templates where all VO partners participate, and manages its negotiation. This management includes several functionalities such as:
  - Open discussion area, to make more agile communication among VO partners, providing functionalities of chat and forum;

- Verify partners proposals and counter-proposals to complete the templates;
- Check partners commitment to a specific co-design template;
- Close a co-design template: once all agreements are reached on a specific template, the co-creation team mediator can close it. After closing, the corresponding template is locked and contents cannot be changed.

- To manage the Agreement Commitment, when all co-design templates are closed and there is no need for further discussion, the co-creation team mediator can generate the document that represents a synthesis of the reached agreements. For that, it is created an agreement proposal document, that after being accepted by all involved partners, evolves to the final agreement and is stored in the electronic notary through the negotiation support for agreement establishment (NegSAEs) module.

In this context, Figure 4.33 illustrates the different flows of interaction that the co-creation team mediator may have with SDAE.

Considering the multi-stakeholder negotiation support environment nature, and that different roles have different permissions / visibility access to the VO information, then different functionalities than the ones available for co-creation team mediator, are available to the other VO partners (including the customer). These functionalities are:

— Participate in the business service co-design edition to which the participant has been invited. For that, the information related to the business service being co-designed is presented, namely, the general information, the supporting documents, the co-design templates, and finally a functionality to accept the agreement document. So, the VO partner can:

- Verify the VO General Information, including the name of the VO for the business service co-design, the customer, the creation date, among others. Functionalities for accepting or rejecting to participate in the VO are also available. In addition, the VO partner can also access to a list of all other involved participants.
- Verify the Supporting Documents, with access to all documents that are important for the business service co-design. The VO partner can preview and download existing documents, but can also suggest new ones.
- Participate in the Co-Creation Templates negotiation, proposing, counter-proposing and negotiating design aspects of the new business service, using the co-design templates: stakeholders mapping and service blueprint diagrams.

- Verify the Agreement Commitment, where if all the discussions are already closed and the co-creation team mediator has generated the VO agreement proposal, each partner may accept and sign it (with the assistance of the electronic notary and registry system).

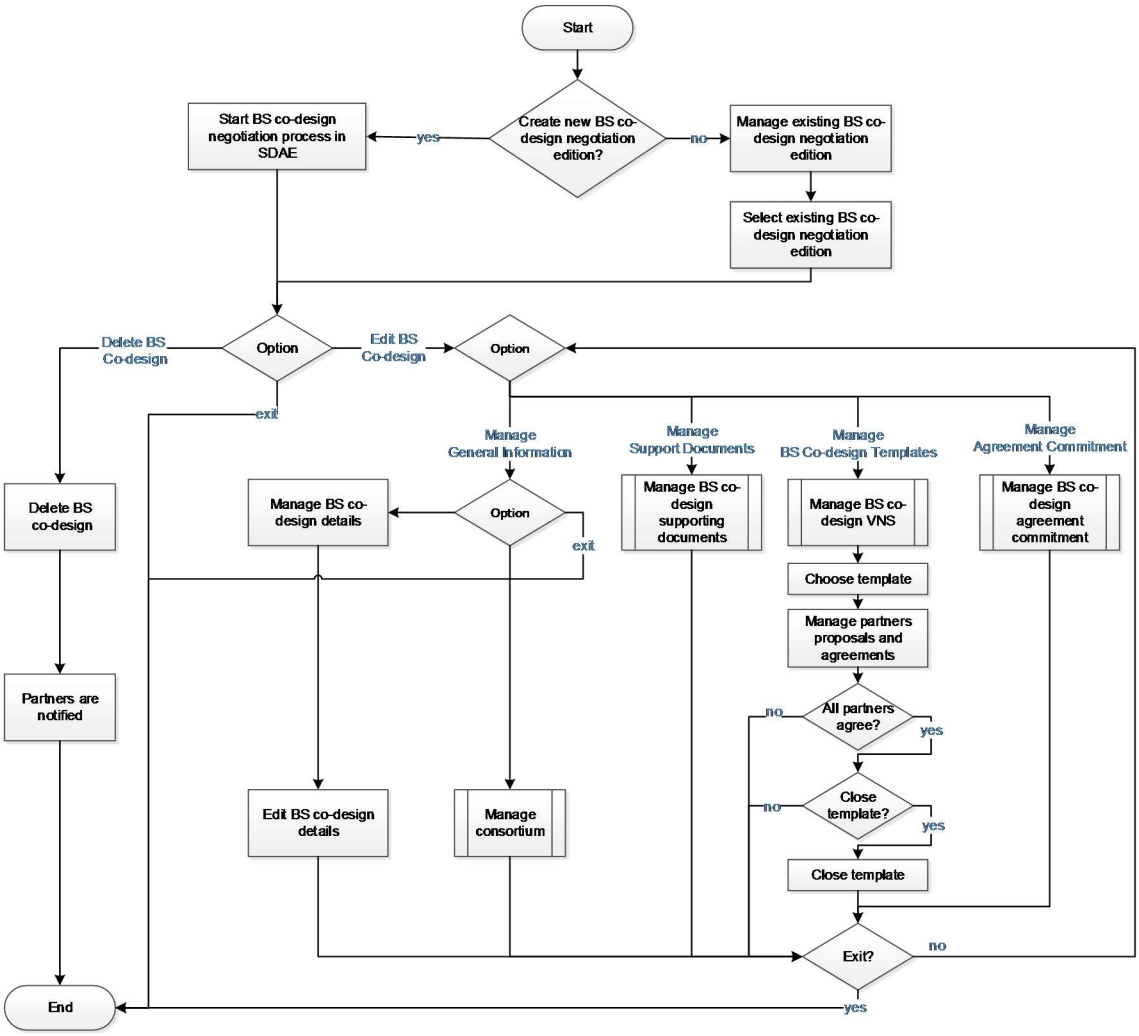

Figure 4.33. Interaction flows of the co-creation team mediator with SDAE

Figure 4.34 illustrates the different flows of interaction that the potential VO partners may have with NegAE.

Considering the main relations of the service co-design agreement editor (SDAE), Figure 4.35 illustrates a partial view of the strategic dependency model initially shown in Figure 4.31, here highlighting the internal decomposition of the main goals and dependences of SDAE. The main tasks of SDAE to satisfy the goal dependencies among related actors and other modules of CoDeN are represented in the model.

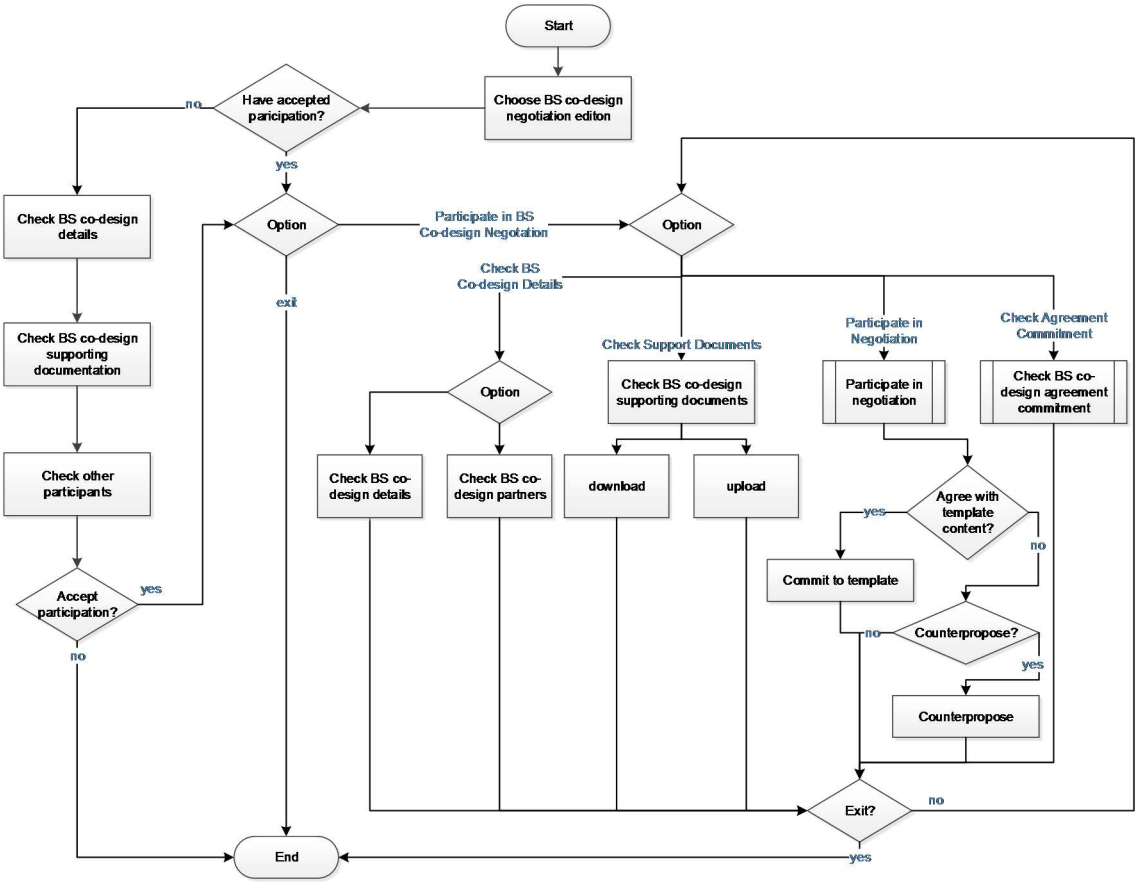

Figure 4.34. Interaction flow of VO partners with SDAE

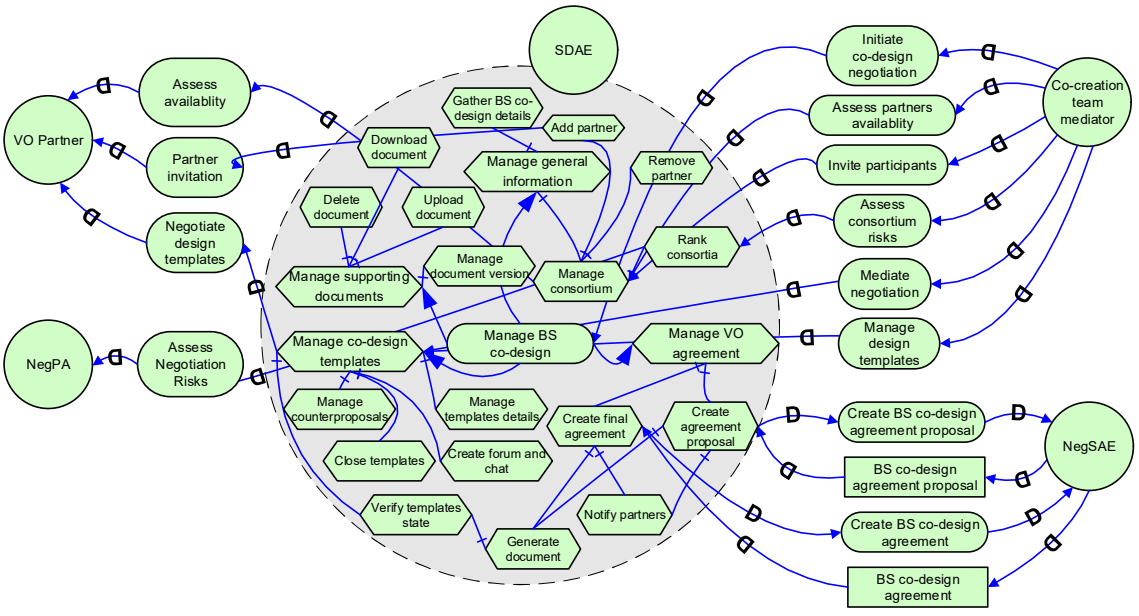

Figure 4.35. Strategic rational model for the co-design negotiation support environment (Partial view – SDAE)

4.5.3.2 Instantiation of the Adopted Negotiation Protocol

In the co-creation case, all participants are requested to participate in the negotiation of all service design templates content. Therefore, considering the adapted negotiation protocol discussed in section 4.3, the participants' interaction with the proposed environment reduces the *moves* $M_{(NT,KNT)}$ to the following:

$$M_{(NT,K_{NT})} = \{propose(NT, K_{NT}), counterpropose(NT, K_{NT}), withdraw(NT)\}$$

being all other moves internally made by the system.

Figure 4.36 illustrates the moves related to the co-creation team mediator's possible states and/or actions considering the interaction with the BS co-design negotiation.

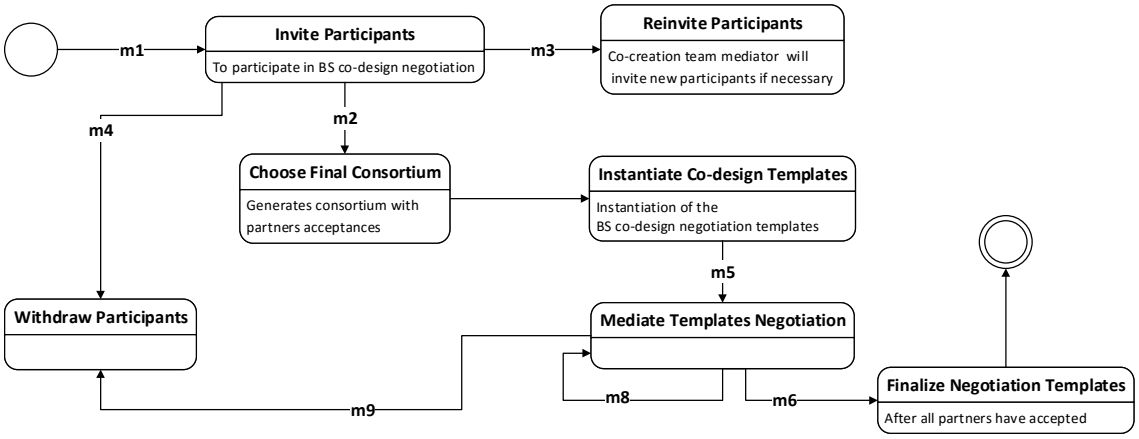

Figure 4.36. Co-creation team mediator's states and related negotiation moves

4.6 Brief Summary

As described in chapter 3, to respond to a collaboration opportunity, when organizations join their competences, they become more prepared. If on one hand, the consortium formation mainly consists in planning, scheduling, and selecting the appropriate partners to join the VO, on the other hand, it is of extreme importance to have a flexible negotiation mechanism that supports the potential VO partners in achieving agreements during the VO creation process, reducing the amount of time spent with it.

In this chapter the proposed negotiation support environment is aimed to contribute to boost the participation in the negotiation of VO creation. As a preparation of negotiation, the proposed system, WizAN is designed to support the VO planner in choosing the suitable consortium, from a list of potential consortia, having into consideration several factors, such as the value system alignment result. To conduct and manage the VO creation negotiation phase, WizAN also includes functionalities for ensuring the potential partners commitments, enclosing required documentation, creating and managing virtual negotiation spaces where the actual negotiation on the negotiation topics are discussed and agreed, and finally generating a document that represents a summary of the established agreements with its supporting documents.

To support collaboration in business services co-design negotiation, this chapter also proposes a negotiation environment to support networks in the form of co-creation teams to achieve agreements on the design of new business services. For this purpose, a negotiation support environment (CoDeN) is described, highlighting the main requirements and approach. CoDeN is intended to provide a collaborative environment for the design of new business services where the various involved participants can reach agreements. The participants (including the customer) in this process are defined a priori, and similarly to WizAN, CoDeN is also intended to generate an agreement that represents the reached consensus. Nevertheless, here there are no free negotiation topics, instead the consensus is guided by a service design methodology that serves as a guide for the negotiation.

Chapter 5 provides a proof-of-concept software environment to support the proposed concepts and models, which were described in this chapter.

5

Proof-of-Concept Implementation

To provide a proof-of-concept of the proposed models and environments, a software system to support the various actors involved in the negotiation process is developed. The software is designed and developed to provide an environment that is not fully automate but aims to assist the human actors in the negotiation during the VO creation process. The full negotiation environment includes functionalities for management of negotiation templates and consortium risk assessment, but also comprises the business service co-design environment system, and an electronic notary and registry system with corresponding interactions.

The purpose of developing a proof-of-concept is to verify that concepts or models are viable and have the potential for solving particular problems (Farlex, 2015). Therefore, this section describes the developed prototypes that are designed to determine the feasibility of the proposed concepts and models described in the previous sections.

5.1 Approach for Software Systems Development

The development approach used in software engineering often follows a methodology that better suits the particular technical and organizational specifications of the intended project (Cockburn, 2000; Charvat, 2003; Kerzner, 2013). Methodologies can vary from classical ones, as the sequential *waterfall* methodology where it is assumed that requirements do not change (Kasser, 2002), to agile development methodologies as

XP and *scrum* that assume a collaborative development and minimal development efforts (Dingsøyr et al., 2012).

The approach that was followed for the design and development of the three proposed systems: WizAN, CoDeN, and e-Notary, is based on a combination of an agile methodology with incremental methodology (Avison and Fitzgerald, 2003; Larman and Basili, 2003).

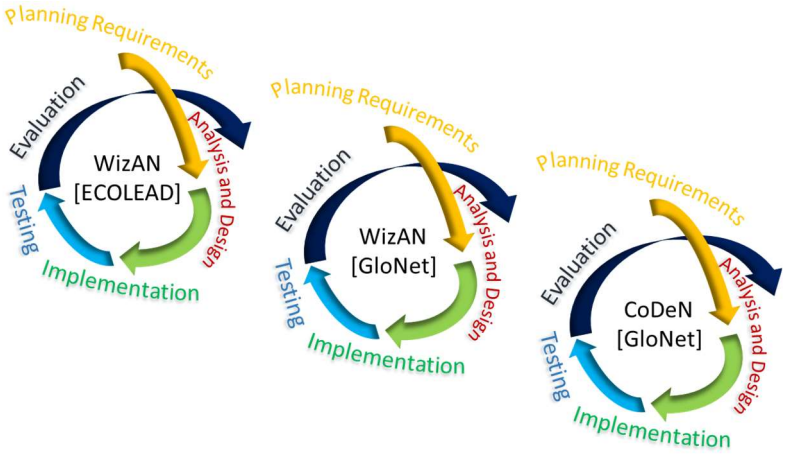

Figure 5.1. Adopted development process

This combination is adopted since the software development was carried out in different contexts, namely in ECOLEAD and GloNet projects. Also, it started with the simplest functionalities and was iteratively enhanced with new requirements or added value functionalities. Figure 5.1 illustrates the followed development process, and Table 5.1 describes the main objectives of each phase of the process.

Table 5.1. Main objectives of the development process

Development process phase	***Main objective***
Planning requirements	To take into account the main requirements to be implemented considering the business context and primary use cases.
Analysis and design	To design the system with a functional coverage of the analyzed requirements.
Implementation	To implement a prototype software system with components and functionalities to support the designed system.
Testing	To test the developed software system in order to identify some faulty elements in the software to easily correct them.
Evaluation	To analyze the implemented and tested software system and evaluate the necessary changes or additional functionalities.

Being this a research work, the aim is not to develop a commercial product, but rather a prototype to demonstrate de feasibility of the proposed concepts and to allow an assessment of its fit-for-purpose.

5.2 Proof-of-Concept Implementation Context

Based on the identified requirements and concepts described in chapter 3 and chapter 4, and the adopted software development approach, the proof-of-concept implementation was carried out. This implementation considered in a first phase the context of the ECOLEAD project, and in a second phase the context of the GloNet project. In GloNet, a complete prototype was developed to support this thesis concepts and proposed framework, providing a direct relation with the developed GloNet system architecture. The main components needed for supporting the service-enhanced products in GloNet environment are illustrated in Figure 5.2, through the GloNet system architecture.

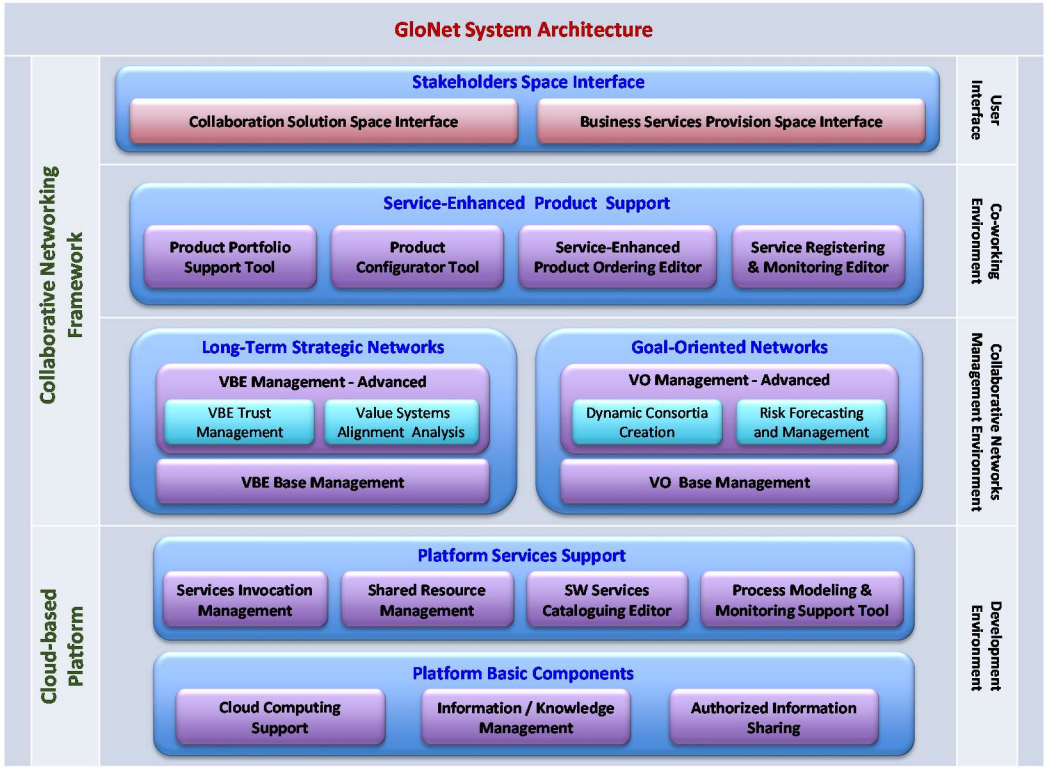

Figure 5.2. GloNet system architecture

The general architecture of the GloNet environment consists of two high-level modules, namely:

— *Cloud-based Platform* - aiming at providing the enabling cloud services for giving support to the development and usability of collaborative functionalities needed for GloNet; and

— *Collaborative Networking Framework* - aiming at providing functionalities needed for collaboration spaces and to support the different forms of collaborative networks, comprising a wide variety of stakeholders that get together in order to create and operate service-enhanced products.

These two high-level modules of the architecture are then divided into a set of layers.

A particularly relevant layer is the *collaborative networks management environment* that aims to give functionality support to the management of long-term strategic networks (VBEs) and goal-oriented networks (VOs).

The functionalities of the long-term networks management include:

— *VBE Base Management*, which aims at providing basic management services along the VBE life-cycle, namely: admission/withdrawal of members; members and network profile and competences; network performance; network's value system, and shared resources incentives.

— *VBE Advanced Management*, which aims at providing advanced management services in order to enrich the VBE life-cycle, namely: functionalities that deal with the trust management among VBE members and functionalities to assess the alignment of their value systems.

Another important element is the set of functionalities *to dynamically create consortia* to quickly respond to a collaboration opportunity, which mostly comply with the VO creation process described in chapter 3. The main functionalities are:

- VO characterization and VBE members' competences analysis, to identify and characterize the new CO and match its requirements with the existing competences in the VBE;
- List of potential VOs, to make a list of all potential consortia combinations according to VBE members competences and VO planner preferences.

It also includes collaborative risk forecasting and management services, and support services for monitoring the involvement of customers and local suppliers.

On top of these components, GloNet introduces a *co-working environment* that comprises a set of support mechanisms for the management and operation of service-enhanced products. GloNet is targeted at supporting complex products and specially the photovoltaic power plants as the guiding use case. Every complex product is composed of a set of different sub-products (e.g. equipment) and sub-systems (e.g. software-based services) provided by different suppliers. Furthermore, complex products require high degree of customization, since customers need products customized to their unique requirements and preferences. Therefore, they need assistance to select the best combination of sub-products that meet their needs as well as the best-fit business services to support the product.

Finally the user interface layer that provides two virtual portals for the collaboration solution space and the business services provision space:

- The *Collaboration Solution Space Interface* aims at providing an access point where manufacturers, local suppliers and customers meet to co-create the product and associated services; and
- The *Business Services Provision Space Interface* aims at providing an access point to the existing products information; here customers can have access to the specific services associated to the customized product.

Given the briefly described functionalities, the prototypes that provide proof-of-concept for this PhD thesis are the ones related to the negotiation during consortium creation: VO creation negotiation support system (WizAN); Business service co-design negotiation system (CoDeN); and Electronic notary and registry system (e-Notary).

5.3 System Implementation

5.3.1 VO Creation Negotiation Support System

5.3.1.1 Overview of Functionalities

The VO creation negotiation support environment system was developed in the form of a wizard, named WizAN (agreements' negotiation wizard) to assist the VO planner in achieving agreements during the VO creation process. This system is divided into five main modules, according to the description given in *section 4.4*:

- Negotiation agreement editor (NegAE): This module provides functionalities to guide the entire VO creation negotiation process, and interacts with the other four

modules: NegPA, NegTM, VNS and NegAE. The main users are the VO planner, the customer, and the potential VO partners;

- Negotiating Partners' Risk Assessment (NegPA): This module provides a support mechanism for the consortium selection, allowing the VO planner to identify and assess the potential risk of a consortium. In order to assess that risk, the value alignment level of a consortium can be assessed using the services provided by the VBE management system, namely services for *Value System Alignment Analysis* of each individual partner;
- Negotiation Templates Management (NegTM): This module manages a collection of agreement templates and a list of pre-defined negotiation topic templates to support the VO creation. In the agreement construction process it is possible to build or edit new agreement skeletons or templates and add them to the collection. Each agreement template contains one or more section templates. Each section template contains one or more field templates. Field templates, section templates and agreement templates can be created, edited and deleted by the user;
- Virtual Negotiation Spaces Management (VNS): This module implements the collaboration space where the potential partners of the VO are invited to join in order to negotiate and/or discuss the necessary topics that need agreement;
- Negotiation Support for Agreement Establishment (NegSAE): This module provides the direct interaction between the negotiation agreement editor and the electronic notary and registry system, whenever the user of the system has the need to store and sign agreements.

5.3.1.2 Requirements

Considering the described overview of functionalities, this section addresses the requirements of the WizAN system considering the external influences, namely from its involved actors, using a set of UML *use case diagrams*.

The relevant stakeholders have been identified in Table 4.1, and for the following diagrams two actors are considered:

- VO planner: as the VBE member that manages the VO creation negotiation process; and
- VO partner: as any potential VO partner in the VO creation process.

The use case diagram presented in Figure 5.3 specifies five sub-systems that correspond to the five modules that are part of WizAN.

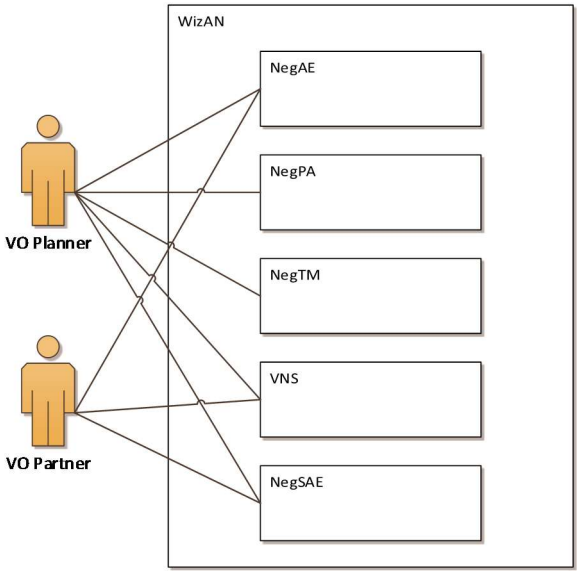

Figure 5.3. WizAN system and sub-systems diagram

Figure 5.4 shows the use case diagram for the negotiation agreement editor functionalities with its main requirements and actors.

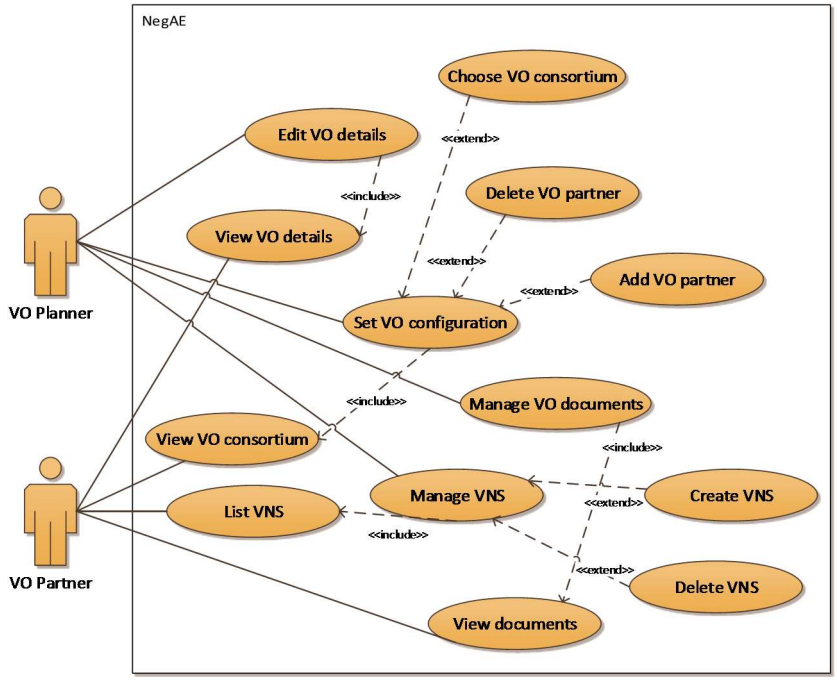

Figure 5.4. NegAE sub-system use case diagram

Figure 5.5 shows the use case diagram for the functionalities related to the negotiating partners risk assessment with their main requirements and actors.

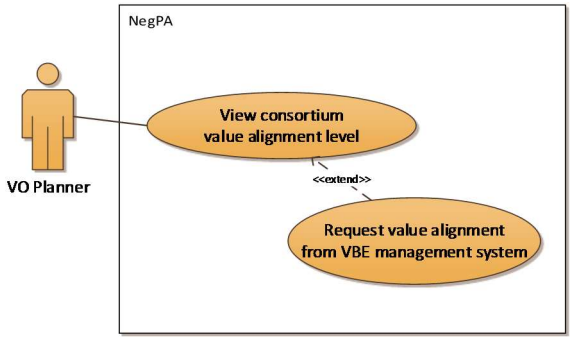

Figure 5.5. NegPA sub-system use case diagram

Figure 5.6 shows the use case diagram for the negotiation templates management functionalities with their main requirements and actors.

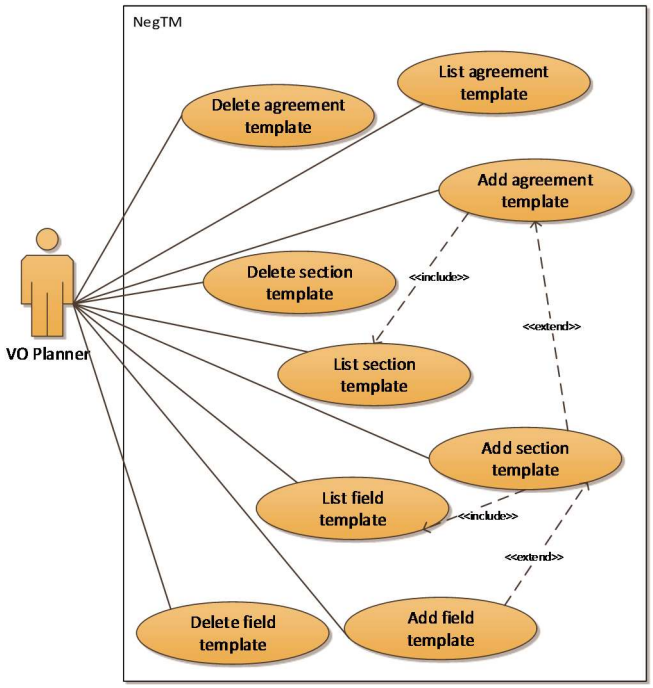

Figure 5.6. NegTM sub-system use case diagram

Figure 5.7 shows the use case diagram for the virtual negotiation spaces management functionalities with their main requirements and actors.

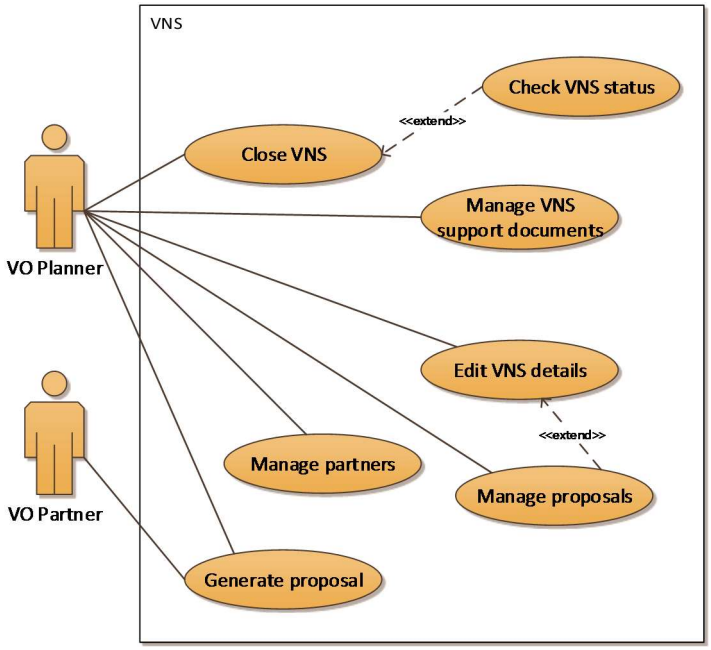

Figure 5.7. VNS sub-system use case diagram

Figure 5.8 shows the use case diagram for the negotiation support for agreement establishment functionalities with their main requirements and actors.

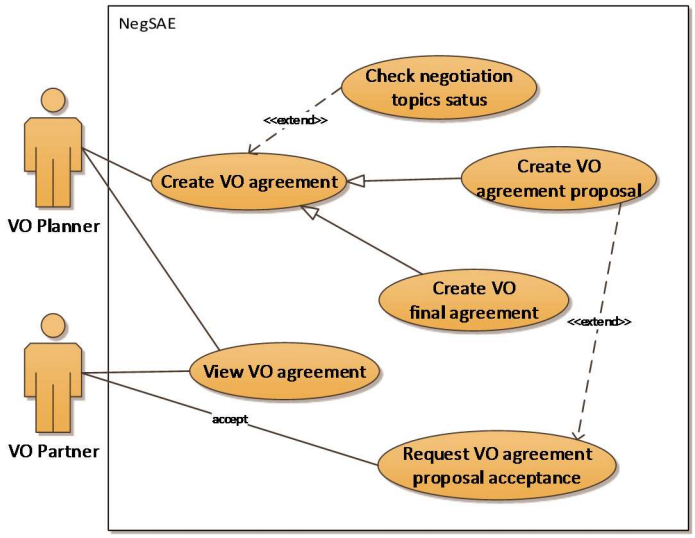

Figure 5.8. NegSAE sub-system use case diagram

5.3.1.3 Implementation Approach

In this section, the described implementation approach is related to the latest implementation of WizAN in the scope of the GloNet project. To cope with the established requirements and specifications, WizAN was implemented as an application system using a 3-tier architecture:

— Data tier: represents the interaction with the database;
— Business logic tier: implements the application logic of the system; reads/writes data from/to the data tier and provides functions (and data) to the presentation tier;
— Presentation tier: represents the web presentation tier for the interaction with the user.

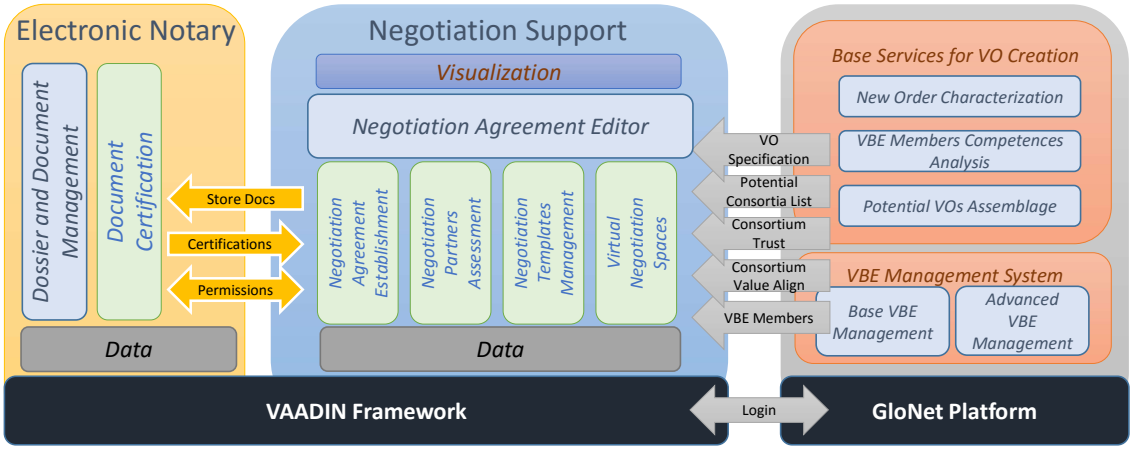

Figure 5.9. Negotiation support data interaction

The negotiation support system was implemented to be used either as a standalone system, or as a component of the GloNet system. As a GloNet component, the negotiation support system can make use of GloNet services, namely the VBE management system, and the VO creation selection services (the analysis of the VO requirements and the partners search and suggestion mechanisms to provide a list of suitable consortia to fulfil the VO requirements). Therefore, WizAN can operate in full integration with the GloNet platform, namely in what concerns login, VBE management system and VO creation selection services, being this integration implemented through web-services.

Table 5.2. Technologies used in the proof-of-concept prototype

Technology	*Purpose*
Java	Programming language
Eclipse Kepler IDE	Eclipse Java Enterprise Edition IDE for Web Developers used in the development of the system prototype
Vaadin Framework	Open source web application framework for Java that includes server-side programming model as well as client-side development tools.
JAX-WS	Java API for XML web services to implement remote Procedure Call-oriented web-services used for the NegPA module
MySQL Workbench 6.0	Workbench for object-relational database management system (ORDBMS)

The interactions with the VBE management system and the selection services for VO creation (Figure 5.9) are implemented using a client service of the interface layer of the GloNet Platform. Web services are also used for the interaction with the electronic notary and registry system. The implementation of the prototype is based on a set of technologies that were combined and are listed in Table 5.2.

5.3.1.4 Information Tables

Figure 5.10 shows the enhanced entity-relationship (EER) model of the designed database (DB) schema used to support the developed concepts for WizAN. The supporting data can be categorized according to six groups:

- **VO general information data:** main general information of the VO being created. It includes information related to purpose, description, VO planner identification, etc. If more information is necessary, it can be easily added. These data are stored in *VO* table.
- **Order specification data:** information that specifies the type and description of CO. It also includes the competences that are required to fulfil the requirements. This information is stored in tables *orderspec*, *goal* and *goal_members*;
- **VO consortium data:** refers to the consortium of the VO. Moreover, a list of all generated potential consorta are available. Tables related to this information are: *consortium* and *consort_memb*;
- **VO documents data:** stores all documents associated to a VO. It is possible to store documents related to the general part of the VO, but also documents related to each individual virtual negotiation space. These elements are stored in table *documents*;
- **VO virtual negotiation spaces data:** refers to the information of the virtual negotiation spaces of a VO. It contains data related to the topics being negotiated and corresponding participants. This information is stored in the following tables: *negotiation_object* and *neg_obj_memb*; and
- **VO agreement data:** contains information of the VO agreement. The information is gathered according to the selected template type. The tables that provide and store information for the VO agreement are the *agreement*, *agree_description_doc*, *agreement_doc*, *agreement_template*, *template_type*, *section_template*, *section _agreement*, *field_template*, *field_type*, and *field_section*.

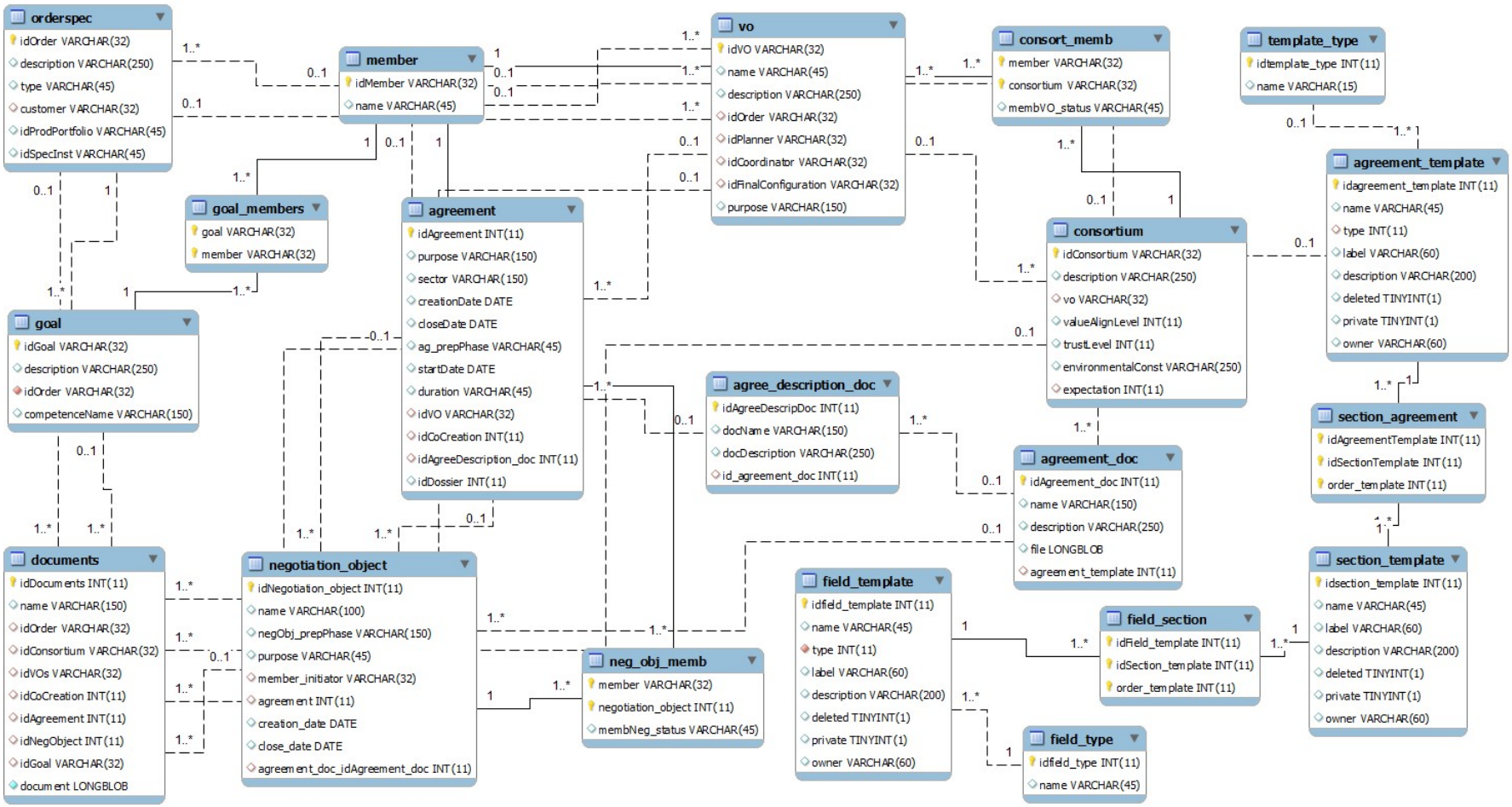

Figure 5.10. EER diagram for the negotiation support system DB

5.3.1.5 Prototype System

The access to the VO creation negotiation support system is split into two different perspectives: a user perspective for the interaction with the human users; and a service perspective for the interaction with other systems' services such as the VBE management system.

User Perspective

WizAN aims to assist both the VO planner and the VO partners in the VO creation phase. Therefore, the prototype provides different functionalities with different permission / visibility access to the VO information, taking into consideration the user roles. In this context, from the login phase the system creates different views for the VO planner and the VO partner as illustrated in Figure 5.11.

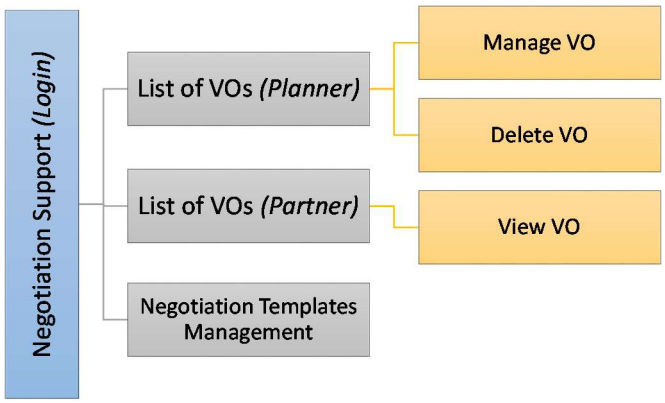

Figure 5.11. Negotiation support prototype navigation map

After logging in, the user has the possibility to manage all VOs that were initiated by him/her (VO planner role) and also to view all VOs where he/she has been invited to participate in (VO partner role). Also, the user can have access to the negotiation templates management so that it is possible to create new or edit existing agreement templates. In Figure 5.12, Figure 5.13, and Figure 5.14 detailed navigation maps for the different roles, as well as for the templates management module are illustrated.

The user interface layout of this prototype was designed to allow access to all functionalities mentioned above. As illustrated in Figure 5.15, the user interface is composed of two main areas: a sidebar to navigate between *My Initiative VOs* (VO planner role) and *Invited VOs* (VO partner role) and a main view were all the related functionalities are presented.

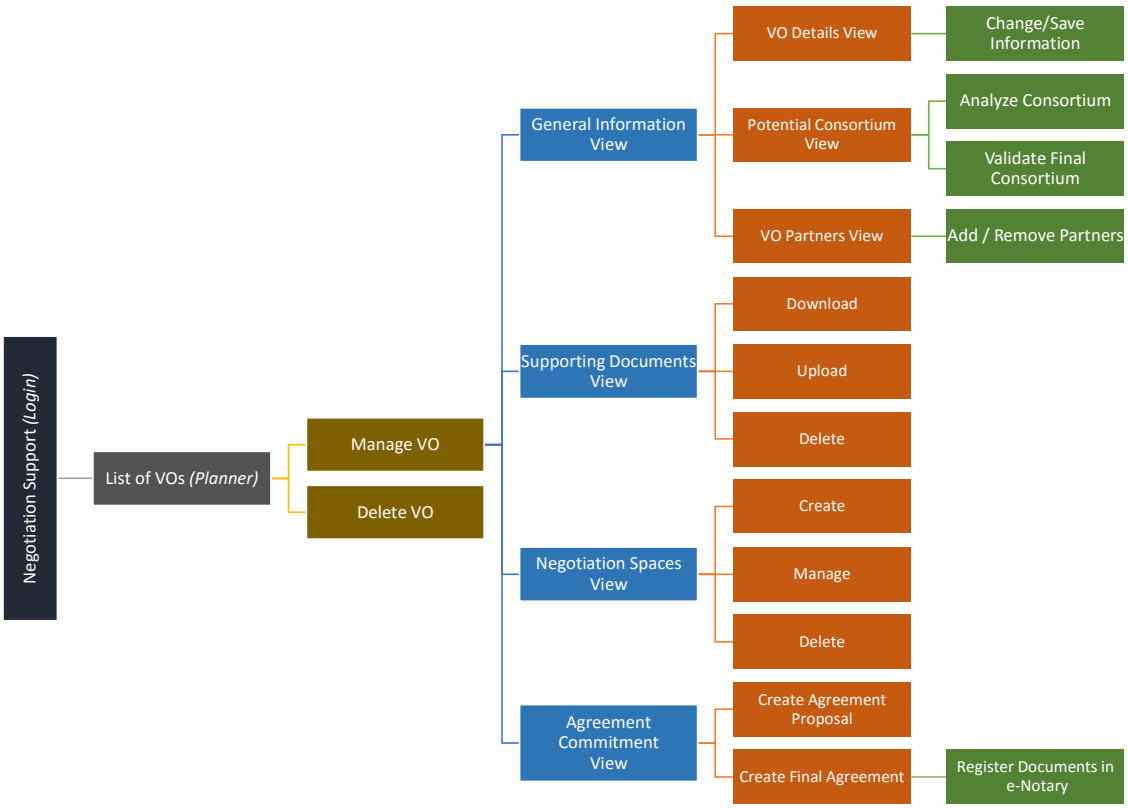

Figure 5.12. Negotiation support prototype navigation map for VO planner

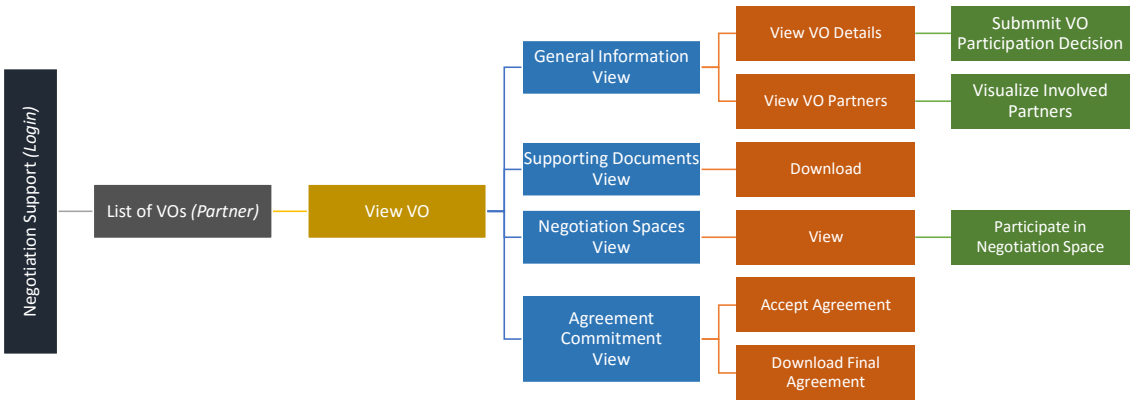

Figure 5.13. Negotiation support prototype navigation map for VO partner

Service Perspective

In order to calculate the value alignment level of a consortium, the negotiation support system, through the NegPA module, interacts with the *Core Values Alignment sub-system* of the *VBE Management System* via web-services. The service is invoked when the VO planner wants to assess the *Value System Alignment Level* for each potential

consortium of the corresponding VO. The index is calculated for each consortium and stored in the correspondent *Consortium* Table of the database. If there is any change in the consortium formation, the VO planner can re-invoke the service in order to update the index value. A similar mechanism can be used to assess the trustworthiness level.

Figure 5.14. Negotiation templates management prototype navigation map

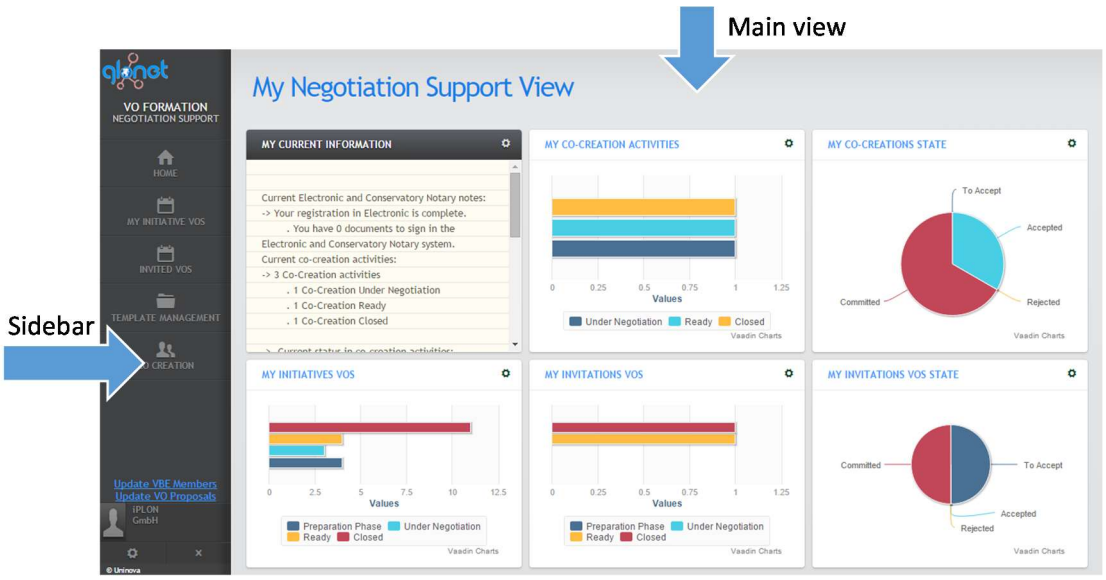

Figure 5.15. User interface layout

5.3.1.6 Examples of Use

Considering the requirements and the implementation approach, this section illustrates some examples of use of the developed proof-of-concept, in a GloNet project scenario of a VO creation with the objective to build a power plant. The following figures present some screenshots of WiZAN system, for both the VO planner, and VO partners.

VO Planner view

Figure 5.16 illustrates an example of the view of the VO planner with the VO details of the power plant.

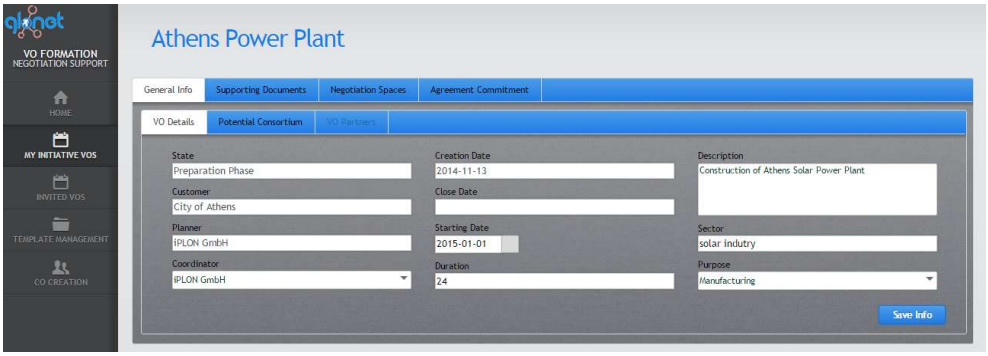

Figure 5.16. VO planner view of VO details

In the *Potential Consortia* view of Figure 5.17, the VO planner has access to a list of the potential consortia that was generated. To assist the VO planner in choosing the most suitable consortium, he/she can rank the consortia by the correspondent value system alignment (button on user interface) and also has the possibility to individually assess the trustworthiness level of the consortium potential partners. In this last case, the VO planner is redirected to the corresponding system in the VBE management system.

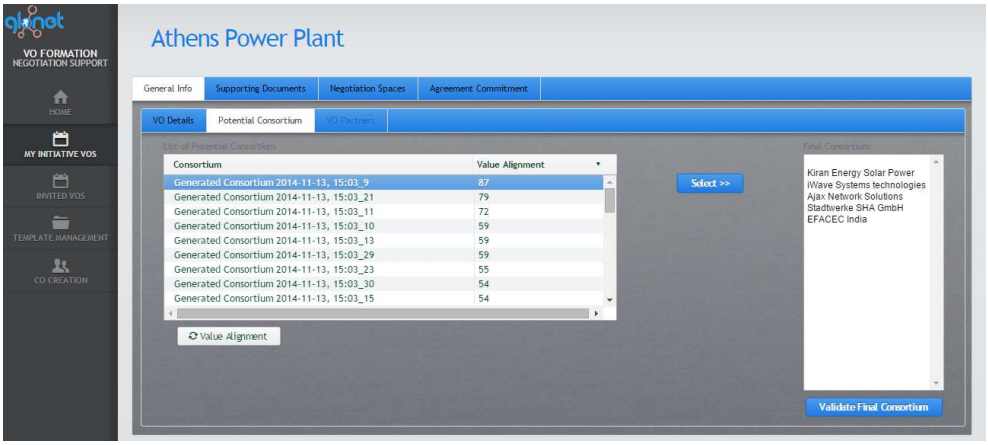

Figure 5.17. VO planner view of list of potential consortia

In order to reach agreements on a specific topic, the VO planner can create a new virtual negotiation space to negotiate that topic. After all VNSs are created, they are listed in the *Negotiation Space* view of the VO planner, as illustrated in Figure 5.18.

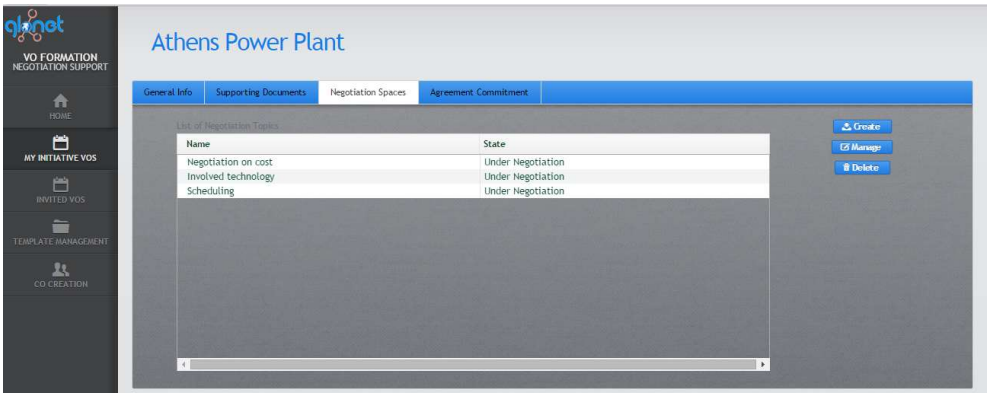

Figure 5.18. VO planner view to manage VNSs

When there is consensus on the documentation of a topic and all the involved participants agree, the VO planner can close the VNS.

VO Partner view

On the VO Partner's side, a list of all VOs where the participant is involved is shown on the *Invited VOs* view. After selecting a VO from the previous list, the VO partner can check the VO details (Figure 5.19).

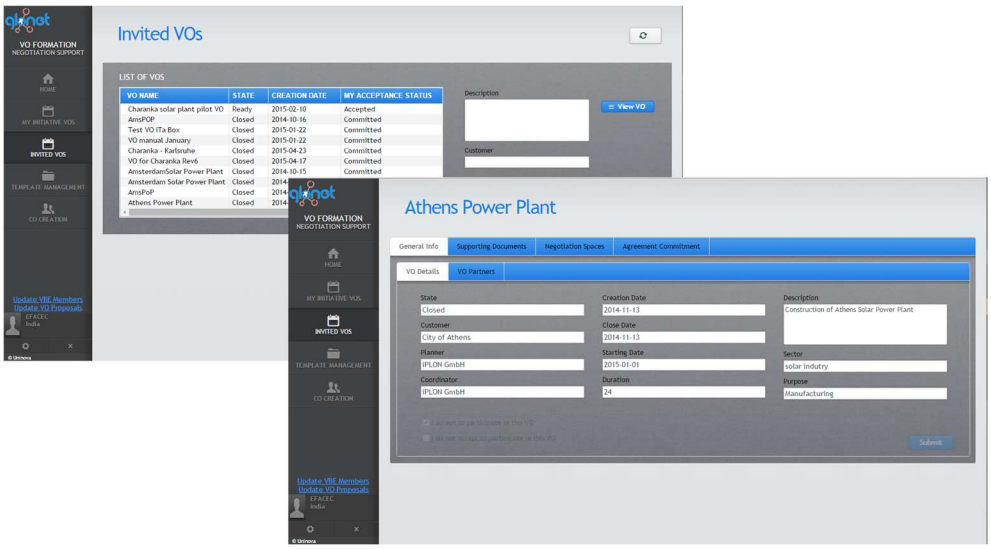

Figure 5.19. List of VO partner's VOs and VO details

To access documentation (e.g. related to technical specification requirements), the VO partner can check the list of supporting documents of the VO (Figure 5.20).

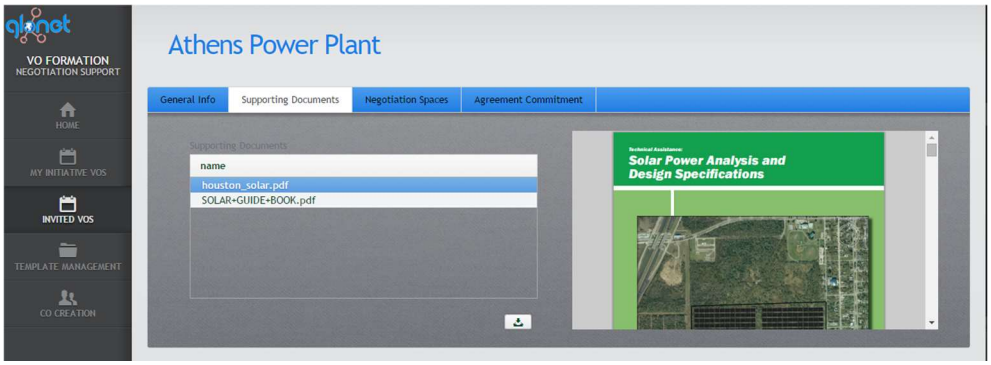

Figure 5.20. VO partner view of VO supporting documents

5.3.2 Business Service Co-Design Negotiation Support System

5.3.2.1 Overview of Functionalities

The Business Services Co-Design Negotiation Support (CoDeN) system is intended to provide a collaborative environment for the design of new business services where the various involved participants can reach agreements on what is needed. The involved participants (including the customer) in this process are defined a priori.

The main functionalities of this system are based on the negotiation support system functionalities (described in the previous section), but adapted to use the mentioned service design methodology. Therefore, the templates that are used in the negotiation space are the ones described in section 4.5.3, namely: stakeholders mapping; blueprint diagrams for user; blueprint diagrams for touchpoints; blueprint diagrams for service direct contact; blueprint diagrams for service back office; and blueprint diagrams for means and processes.

5.3.2.2 Requirements

Considering the overview of functionalities, this section addresses the requirements of the CoDeN system considering the external influences, namely from its involved actors, using a set of UML *use case diagrams*. The relevant stakeholders have been identified in Table 4.8, and for the following diagrams two main actors are considered:

— Co-creation team mediator: as the VBE member that manages the new business service co-design negotiation process; and

— Participant: as any other participant of the co-creation team, namely a VO partner and a customer.

The use case diagram presented in Figure 5.21 specifies three sub-systems that correspond to the three modules that are part of CoDeN.

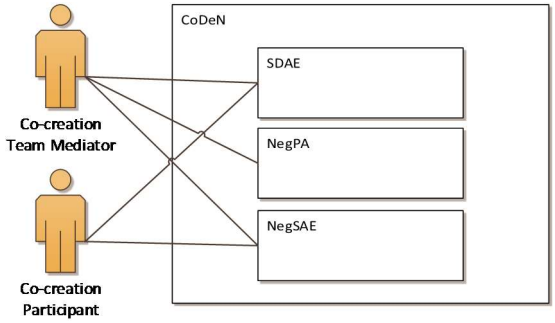

Figure 5.21. CoDeN system and sub-systems diagram

Figure 5.22 represents the use case diagram related to the sub-system SDAE with the main requirements and actors, while the NegPA and NegSA sub-systems are already represented in the previous use case diagrams of Figure 5.5 and Figure 5.8 respectively.

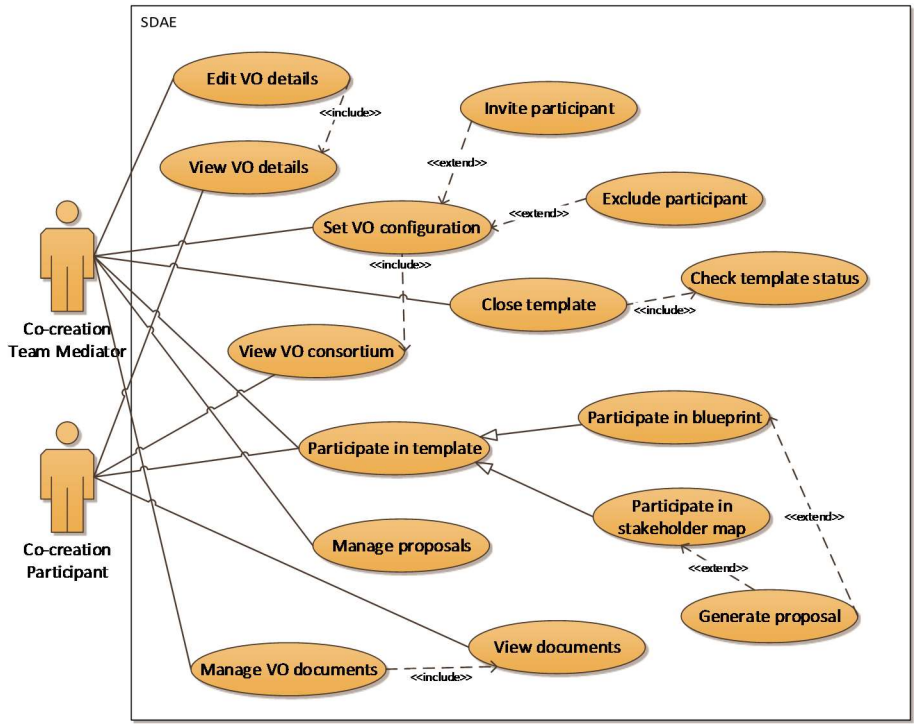

Figure 5.22. NegAE sub-system use case diagram

5.3.2.3 Implementation Approach

The CoDeN implementation is also based on the VAADIN framework and can operate either as a standalone system, or in full integration with the GloNet platform (namely in what concerns login and VBE management system). The integration is implemented through web-services.

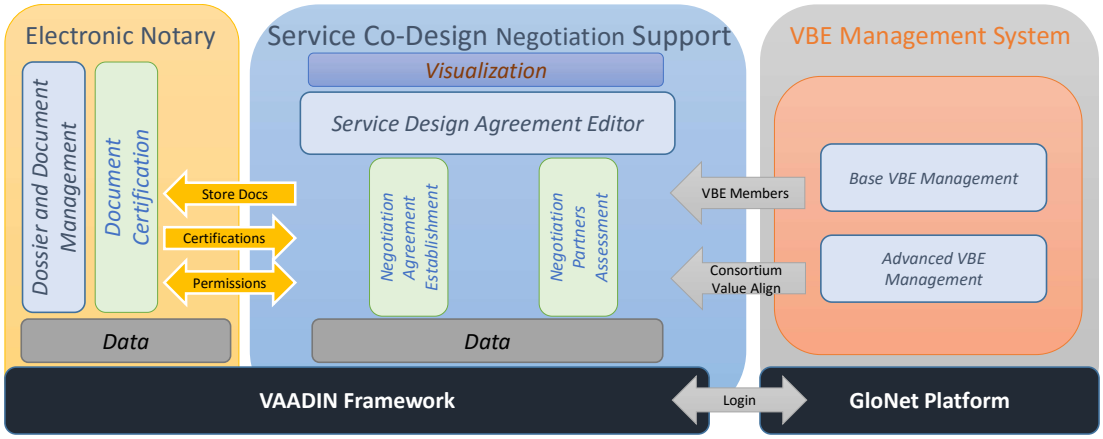

Figure 5.23. Business service co-design negotiation support data interaction

Similar to the WizAN system, the interactions with the VBE management system and the VO creation selection services are implemented using a client service interface layer of the GloNet Platform. Web services are also used for the interaction with the e-Notary system. The technologies used in the implementation of the proof-of-concept prototype are the ones mentioned in Table 5.2.

5.3.2.4 Information Tables

The CoDeN system followed the conceptual model described in section 4.5, and Figure 5.24 illustrates the EER model of the design of the database schema.

The supporting data of CoDeN can be categorized according to five groups:

- **General business service co-design information data:** gathers the main general information of the co-design team. It includes information related to description, co-creation team mediator, customer, etc. If more information is necessary, it can be easily added. This data is stored in *co_creation* table.
- **BS co-design consortium data:** refers to the consortium that will form the VO for BS co-design. Tables related to this information are: *consortium* and *consort_memb*;
- **BS co-design documents data:** stores all documents associated to the VO for BS co-design. The associated data is stored in table *documents*;

— **BS co-design methodology data:** refers to the information of the blueprints and stakeholder mapping for the BS co-design. This information is stored in the following tables: *stakeholders_mapping*, *stkmapping_memb*, *blueprint*, *blueprint_template*, and *blueprint_memb*; and

— **BS co-design agreement data:** stores the information related to the agreement that reflects the BS co-design negotiation. The tables that provide and store information for the agreement are the *agreement*, *agree_description_doc*, and *agreement_doc*.

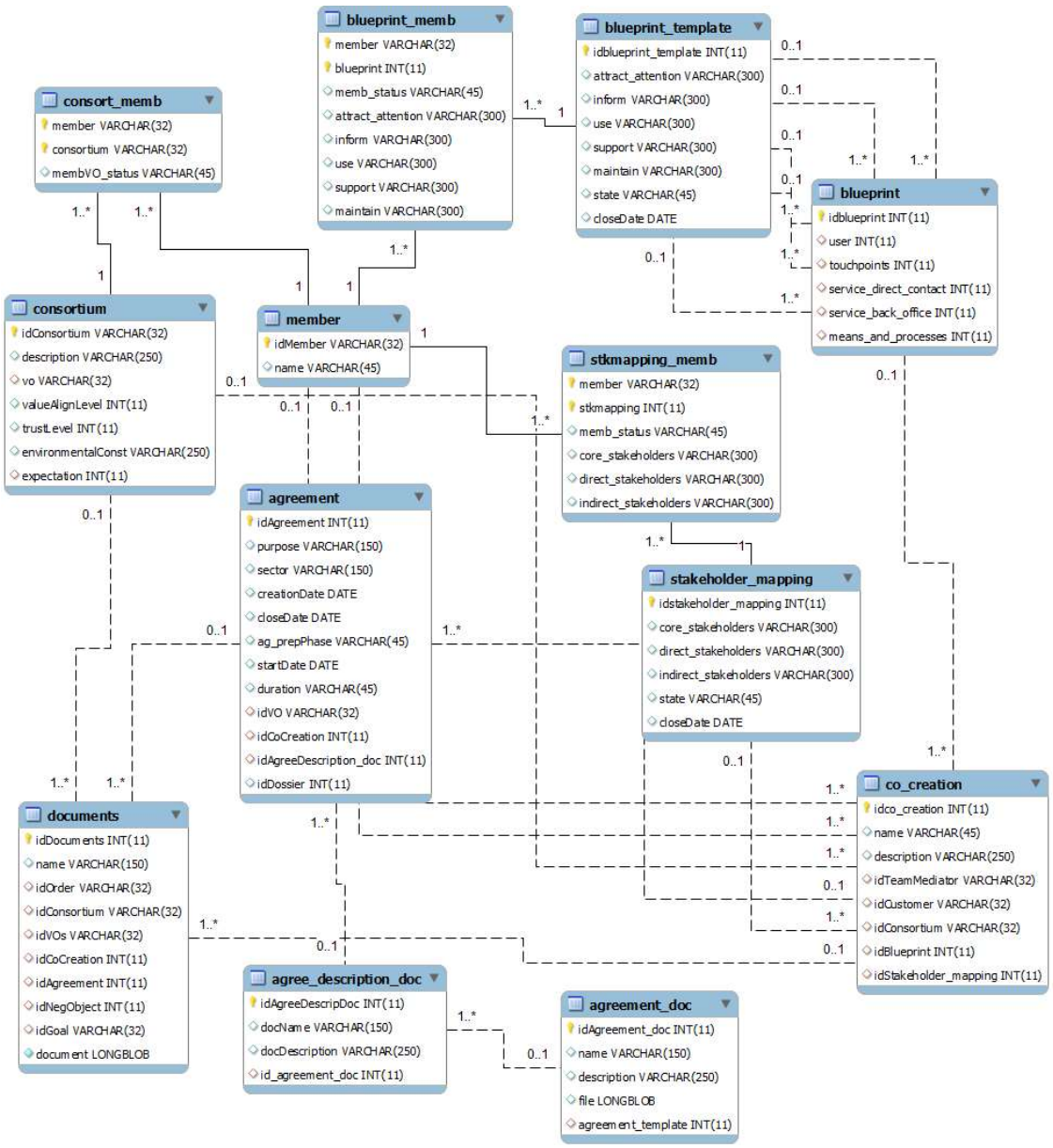

Figure 5.24. EER diagram for service co-design negotiation support system DB

5.3.2.5 Prototype System

Similar to the access to the VO creation negotiation support system, the CoDeN proof-of-concept implementation is split into two different perspectives: a user perspective, for the interaction with the human users; and a service perspective, for the interaction with other systems' services such as the VBE management system. In this last case, it was used the same approach as the one followed in WizAN system. Figure 5.25 and Figure 5.26 illustrate the detailed navigation map for the co-creation team mediator and the other co-creation team participants, correspondingly.

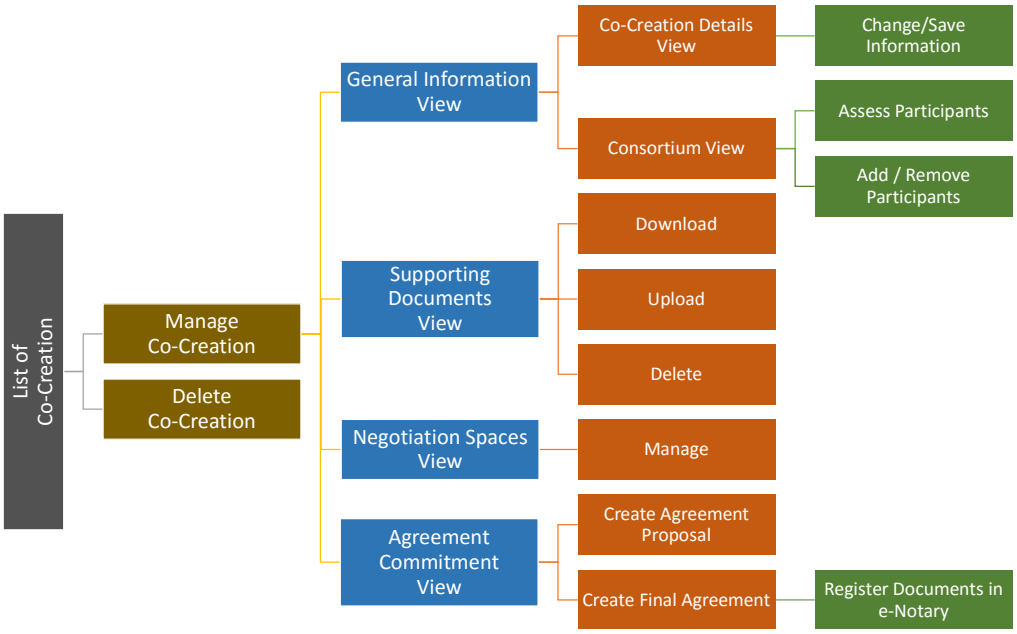

Figure 5.25. CoDeN prototype navigation map for co-creation team mediator

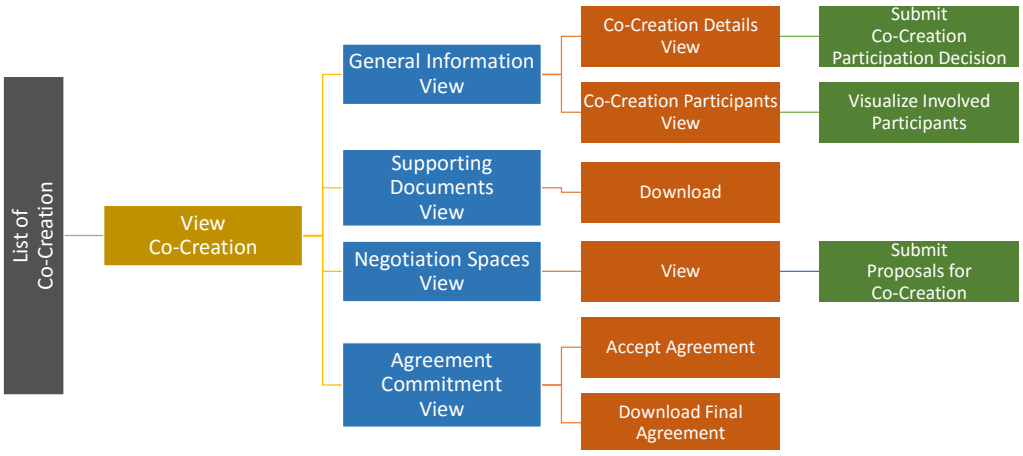

Figure 5.26. CoDeN prototype navigation map for co-creation team participant

The CoDeN system followed the same development approach concerning the user interface layout as the WizAN system (Figure 5.15).

5.3.2.6 Examples of Use

Considering the requirements and the implementation approach, this section illustrates some examples of use of the developed proof-of-concept in a GloNet project scenario of a *String Monitoring service co-design* for a power plant. The following figures represent some screenshots of the CoDeN system, starting in Figure 5.27 that illustrates the entry point to the CoDeN system with a list of existing co-creations for new business services for the current user.

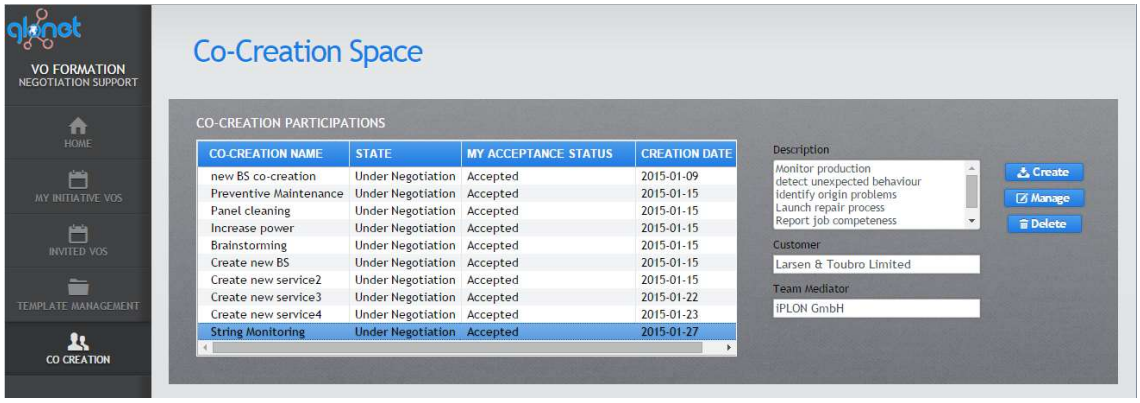

Figure 5.27. Main view of the service co-design negotiation support prototype

It is then possible to create new co-creation spaces or to manage one from the list on the left. When the current user takes the initiative to create a new co-creation space, automatically he/she becomes the co-creation team mediator of the new business service co-creation.

Figure 5.28 illustrates the view of the co-creation team mediator with the co-creation details, and shows the same but for a participant with the option to participate, or not, in the current co-creation.

To assist the co-creation team mediator in choosing the most suitable consortium, he/she can rank the consortia by the correspondent value system alignment. Also the possibility to individually assess the trustworthiness level of the consortium potential partners is available through the corresponding functionality of the *VBE management system*. It is possible to add, remove or replace members as illustrated in Figure 5.29.

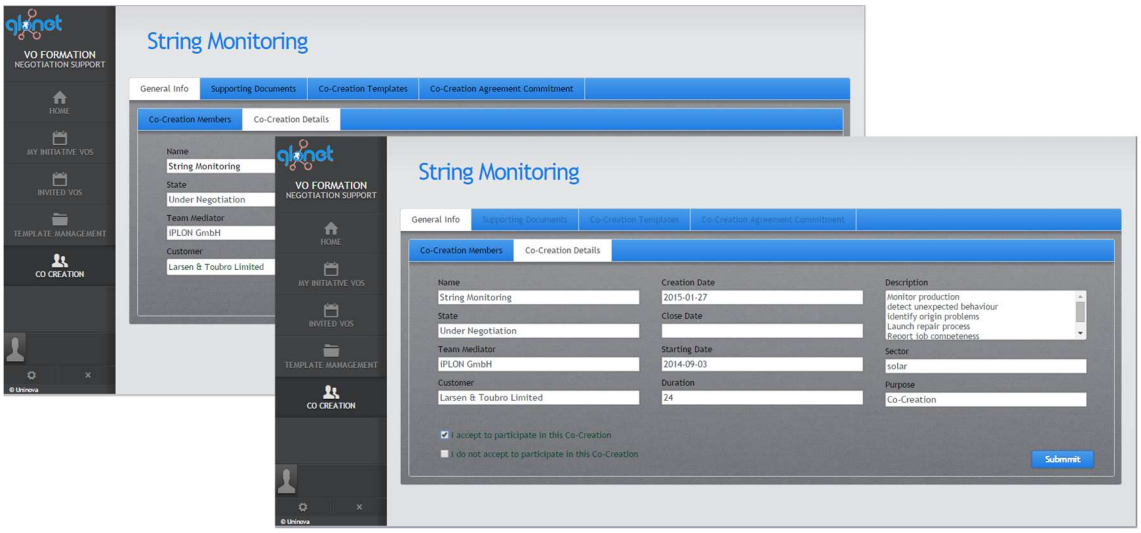

Figure 5.28. Co-creation team mediator and participant view of co-creation details

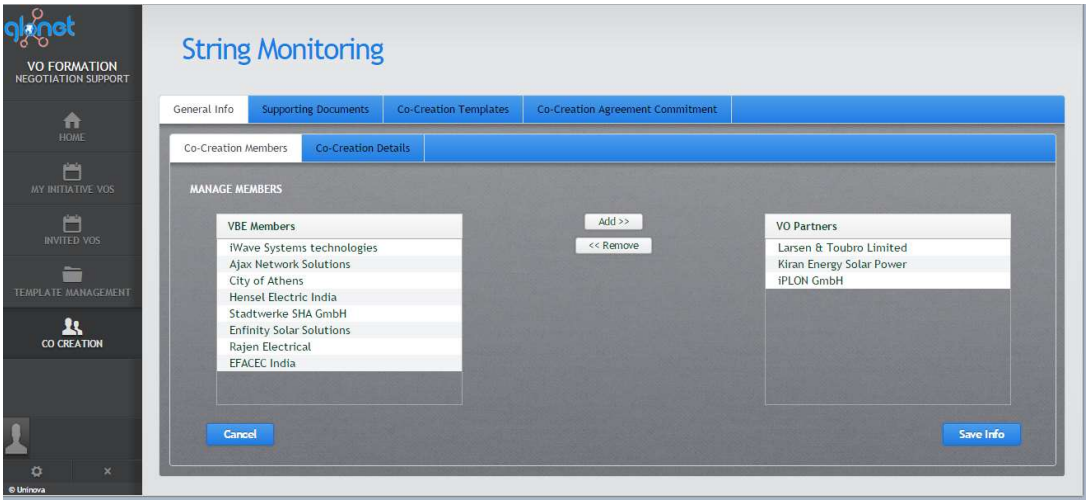

Figure 5.29. Co-creation team mediator view of co-creation member's management

To follow the adopted service design methodology, the co-creation team needs to discuss the main interactions that the new service will have. For that, the co-creation team makes use of the blueprint templates: *user*, *touchpoints*, *service direct contact, service back office,* and *means and processes blueprint*. Also, a template to define the identification and mapping of the relevant Stakeholders for the new business service is available (*Stakeholder mapping template*). Figure 5.30 exemplifies the areas/topics of negotiation in each blueprint. The co-creation team mediator is the one responsible for editing the information. Therefore, he/she can do it based on the documentation support (on the *Supporting Documents* tab) or on the counter-proposals that the other co-creation team participants can make.

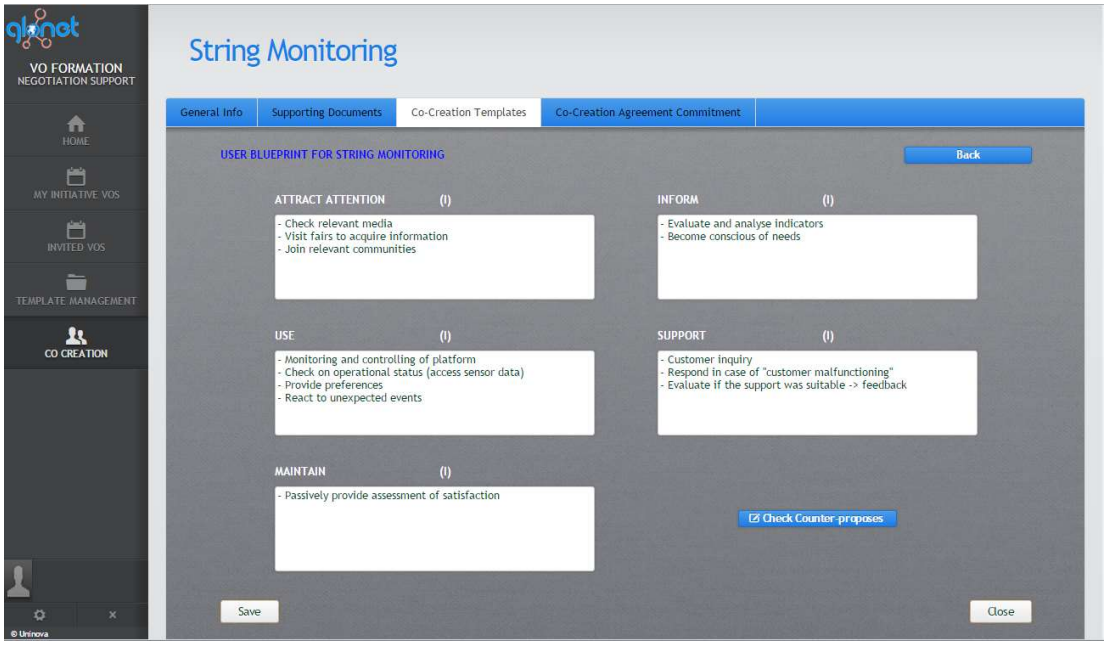

Figure 5.30. View of the negotiation topics for a blueprint template

Figure 5.31 illustrates an example of a counter-proposal made by another co-creation participant in the team mediator view.

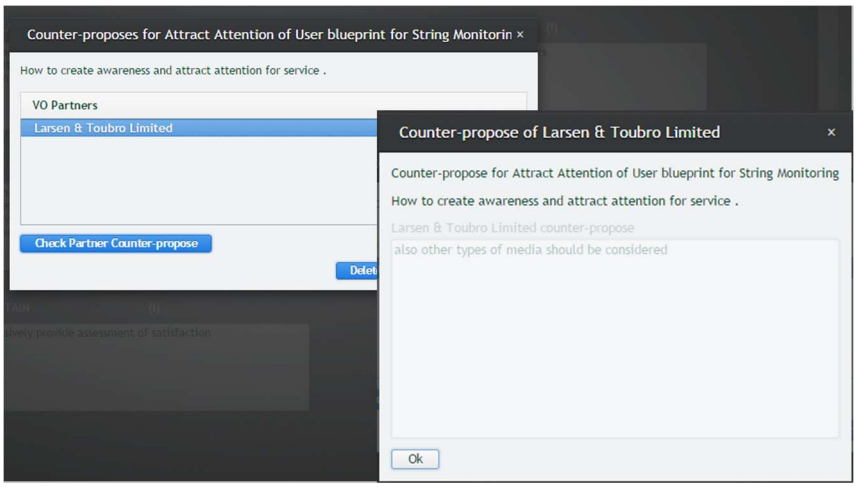

Figure 5.31. Example of a counter-proposal on a specific topic

Similar to the WizAN system, after all the information and templates content are discussed and agreed, the co-creation team mediator can generate the agreement.

5.3.3 Electronic Notary and Registry System

5.3.3.1 Overview of Functionalities

As mentioned in section 3.6, the electronic notary and registry system provides its users with mechanisms for signing documents and the possibility of exchanging agreements documentation with warranty of authenticity and validity, as well as providing a safe archive for such documentation. In this system, the following main concepts are used:

- *Negotiation Dossier*: defined as a compendium of several documents involved in a negotiation. In this context, the dossier represents a set of documentation for a specific consortium agreement, that is, a package of documents that support the consortium agreement;
- *Signature*: refers to a digital signature of a document. A consortium agreement, in order to be valid, will be signed by all involved partners; and
- *File Certification*: represents the veracity of a document. An authorized VBE member may verify if a certain document has been signed by all involved entities.

Depending on the corresponding permissions, the user of the system can properly manage dossiers, sign, and verify document signatures.

5.3.3.2 Requirements

Considering the overview of functionalities and description in section 3.6, this section addresses the requirements of the e-Notary system considering the external influences, namely from its involved actors and other systems, using a set of UML *use case diagrams*. In this case, the relevant stakeholders are the e-Notary users and the other external systems are the WizAN and CoDeN systems, namely through the functionalities of the NegSAE module. Figure 5.32 illustrates the e-Notary system use case diagram.

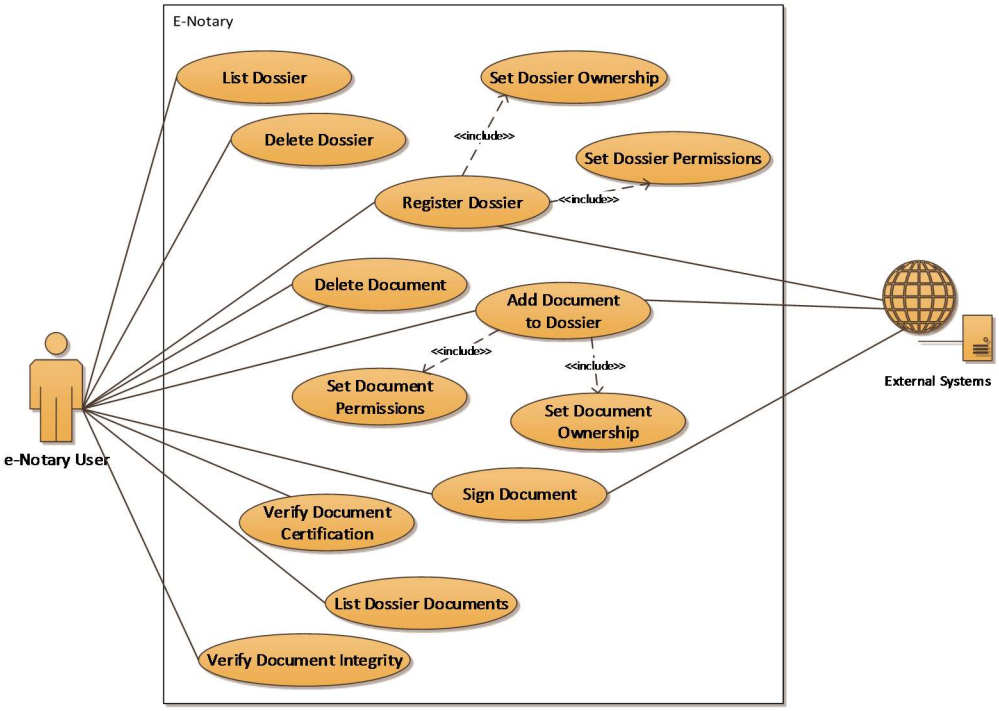

Figure 5.32. e-Notary system use case diagram

5.3.3.3 Implementation Approach

Similar to the previous systems, the e-Notary is also implemented based on the VAADIN framework, and can be either used as a standalone system, or operate in full integration with the GloNet platform using a client service interface layer, namely in what concerns login and VBE management system. This integration is implemented through web-services.

The technologies used in the implementation of this prototype are the ones mentioned in Table 5.2. For the signature process, a Public-key or asymmetric cryptography algorithm is used.

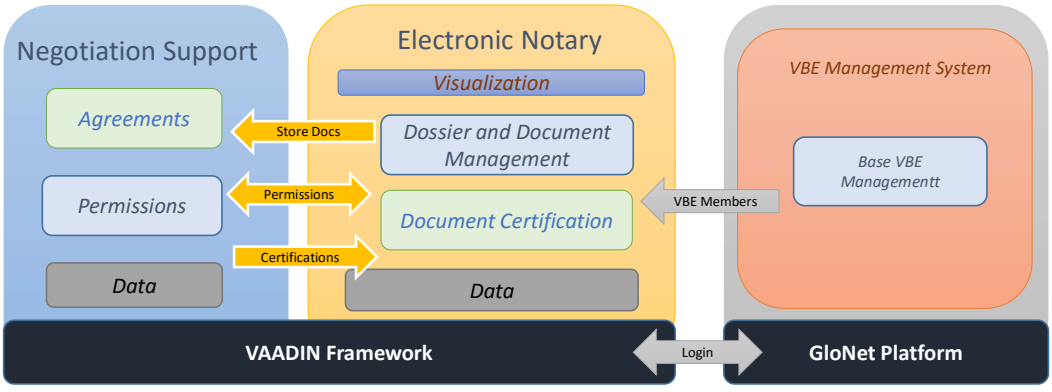

Figure 5.33. Electronic notary and registry system data interaction

5.3.3.4 Information Tables

The information tables implemented for the electronic notary and registry system followed the conceptual model described in section 3.6. In Figure 5.34 the EER diagram of the design of the database schema is illustrated.

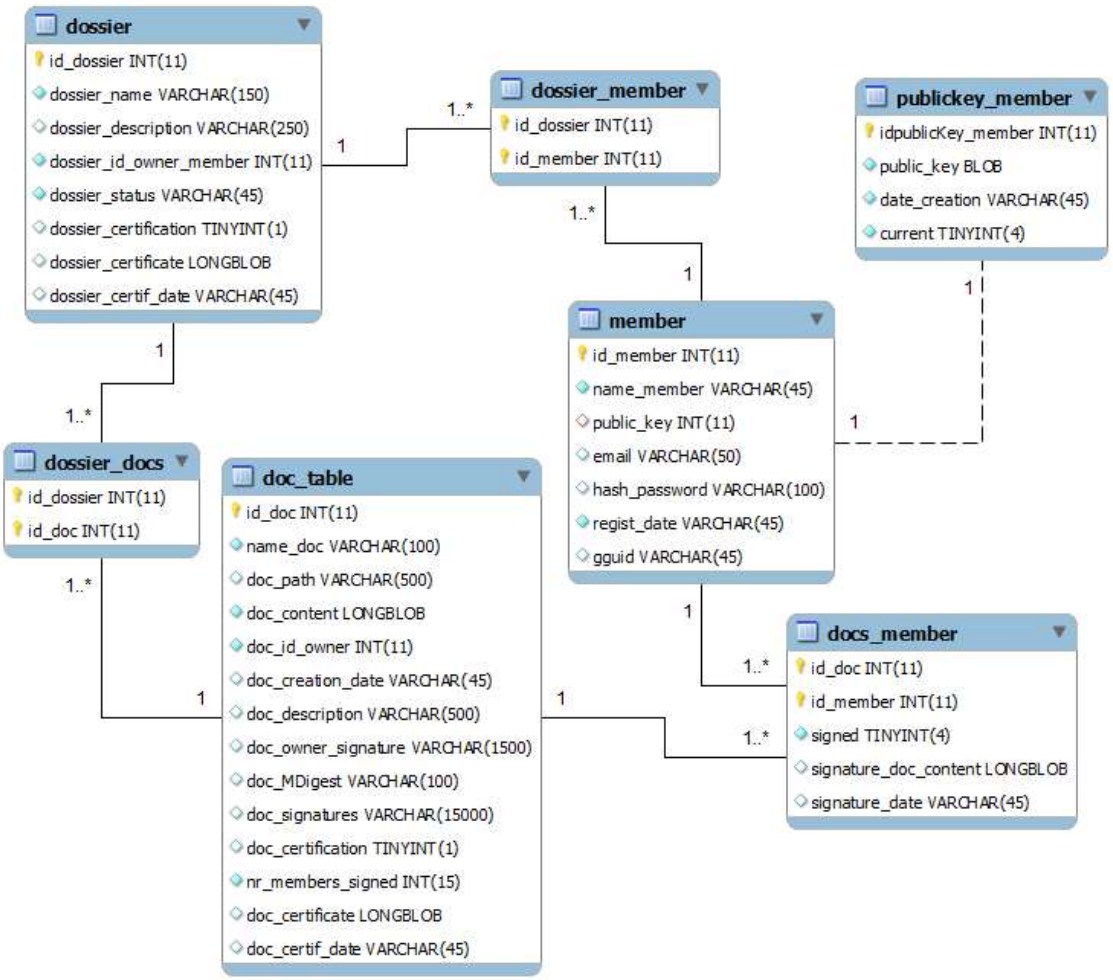

Figure 5.34. EER diagram for electronic notary and registry support system DB

The supporting data for the e-Notary system can be categorized according to three groups:

— **E-Notary member data:** general information of the members registered in the e-Notary system. It includes information related to name, email, registration date, etc. At registration, members are automatically endorsed with a public and private key, that can be retrieved and/or changed at anytime. This information is stored in tables *member* and *publickey_member*;

- **E-Notary dossiers related data:** comprises data related to the e-Notary dossiers including the members' access permissions. The tables that provide and store information for dossier related data are the *dossier*, *dossier_member*, and *dossier_docs*;
- **E-Notary documents related data:** includes the documentation that is stored in the e-Notary system. Information includes members' signature, certification, dates, etc. The tables that provide and store information for documents related data are the *doc_table*, and *docs_member*.

5.3.3.5 Prototype System

The e-Notary system directly interacts with the VO creation negotiation support system and with the business service co-design negotiation support system. The system implementation[1] is divided into two different perspectives: a user perspective for the interaction with the human users; and a service perspective for the interaction with the other systems.

User Perspective

The user perspective of the e-Notary system supports the VO planner and/or the co-creation team mediator in the digital signature and verification of agreement documents. The developed prototype provides different functionalities with different permission / visibility access. Functionalities include management of dossiers, signatures, documents certificates, etc. Figure 5.35 illustrates the navigation map of the main functionalities of the developed prototype.

[1] E-Notary was developed as a MSc thesis (Boavida, 2015) to which the author of this thesis gave major contribution to the design and guidance during implementation.

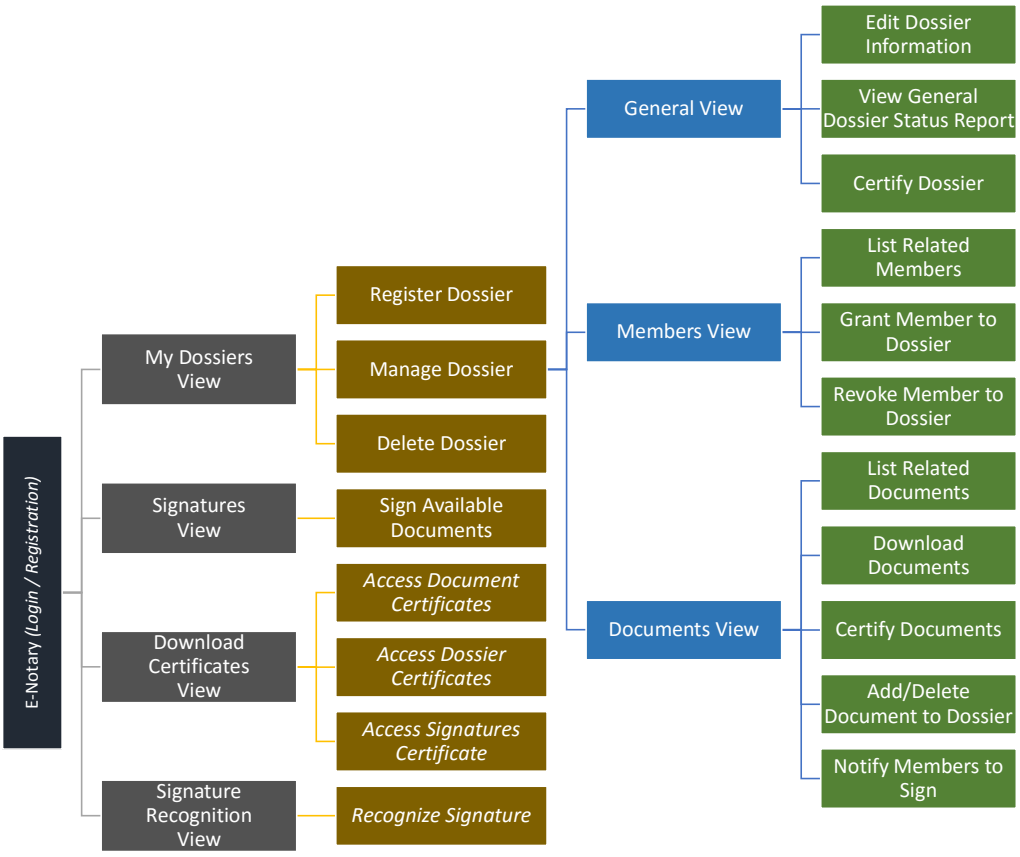

Figure 5.35. Electronic notary and registry prototype navigation map

Service Perspective

The e-Notary system also provides services to other systems via web-services, namely to the WizAN and CoDeN systems. The services are related to:

- Register members in the e-Notary system;
- Register dossiers (service used by the VO planner and/or the co-creation team mediator to register a set of documentation); and
- Add documents to existing dossiers.

It is also possible to get the number of documents that a user has pending for signature.

5.3.3.6 Examples of Use

Considering the requirements and the implementation approach, this section illustrates some examples of use of the developed proof-of-concept, that are represented in the following figures with some screenshots of the e-Notary system.

In *My Dossier* tab of the sidebar, the e-Notary user can register, manage or delete a *Dossier*. In the *Manage Dossier* tab of the sidebar, the system provides users with all information and services related with the corresponding *Dossier*, allowing them to manage the dossier member permissions, or/and its documents.

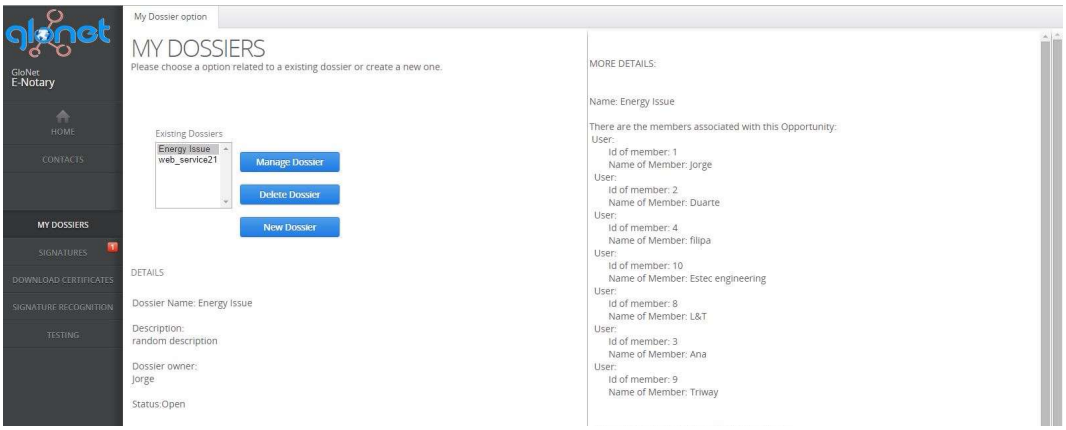

Figure 5.36. e-Notary – *My Dossiers* view

In the "add document" functionality presented in Figure 5.37, the user has to choose the document he/she wants to upload to the system, choose the members that will have permission to access and consequently sign it. To be able to do this, the user has to provide his/her private key to assure his/her authenticity.

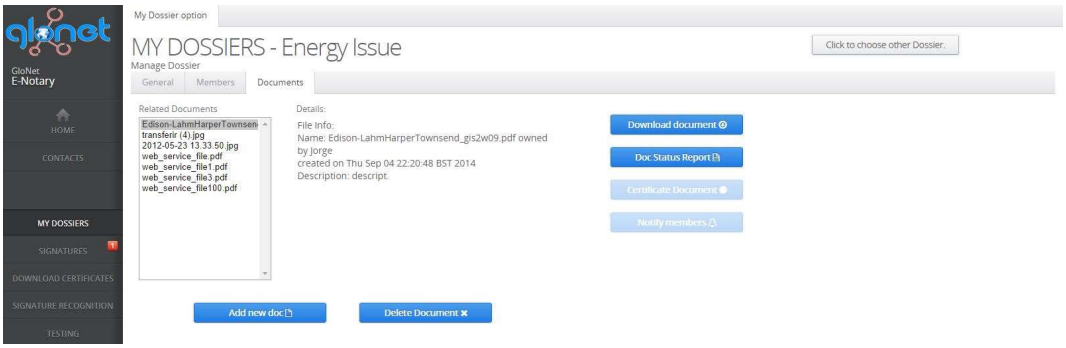

Figure 5.37. e-Notary – *Document* view tab

In the *Signatures* view, a user can verify the status of all documents and dossiers to which he/she has been granted permission.

If the user has any document pending of signature, he/she can sign it in the corresponding space, as illustrated in Figure 5.38.

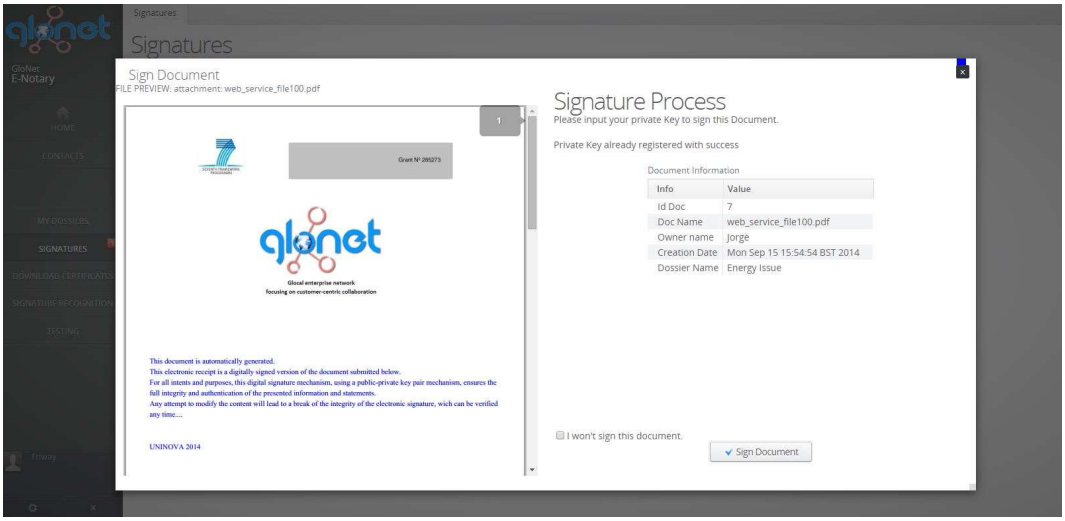

Figure 5.38. e-Notary – sign process view

All certificates and signatures generated by the system are available to be downloaded. The list of available certificates is related with the user's permissions.

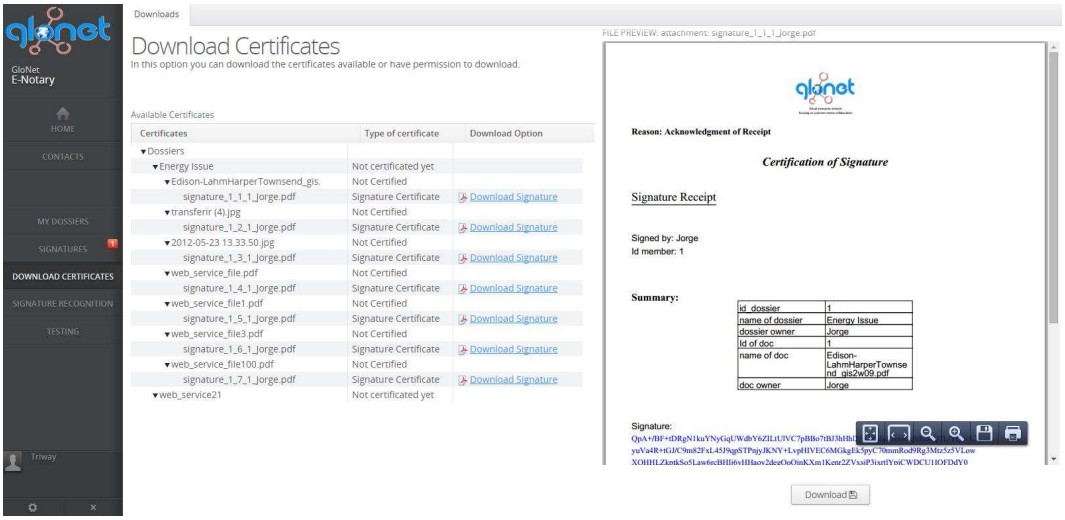

Figure 5.39. e-Notary – *Download* view functionality

Figure 5.40 illustrates the view for *Signature Recognition*. In this area, any member can verify the authenticity and validity of a document certificate.

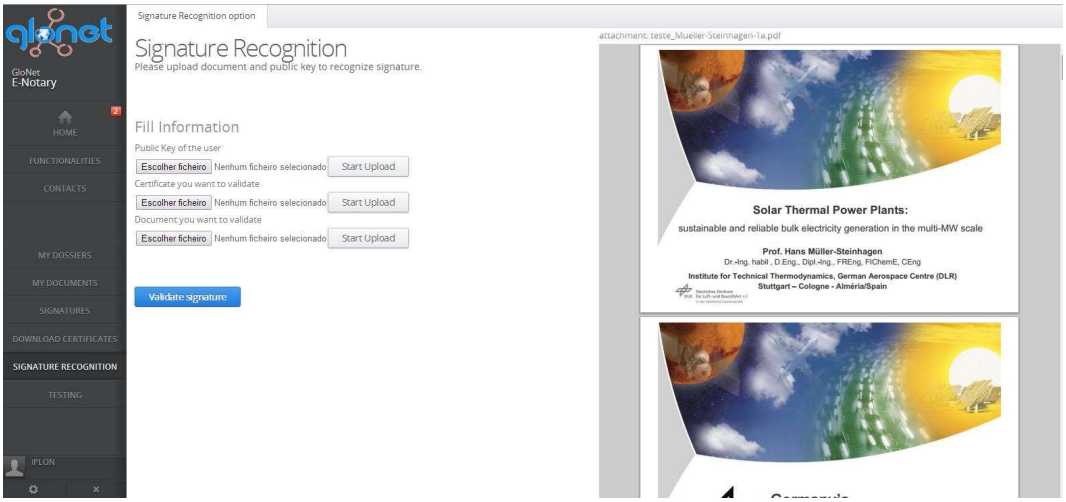

Figure 5.40. e-Notary – signature recognition functionality

5.4 Brief Summary

This chapter described the proof-of-concept software implementation for the VO creation negotiation support system, business service co-design negotiation support system, and electronic notary and registry system. The requirements for the three systems are gathered fundamentally from the environments proposed in section 3.6 and chapter 4, that are a result of the research work presented in this thesis. Refinements were iteratively performed considering literature review, but also in close interaction with potential end-users of the systems, namely experts that participated in both ECOLEAD and GloNet European research projects.

The main contribution of this chapter is not the developed prototypes per se, but the assessment of feasibility and usability of the environments proposed in chapters 3 and 4 for future developments to be used in real world.

Next chapter describes the aspects of validation of the proposed models, software environments, and corresponding implementation.

6

Validation

Validation is a fundamental stage in every research work. As such, this chapter presents the followed validation methodology that is based on three main elements: validation in the research community, validation in a solar industry network, and validation by comparison with other solutions. The chapter ends with some validation findings, evaluating and discussing the proposed thesis.

One important step of each research work is its validation. In the case of the proposed work, the question that arises at this point is how to validate the achieved results. For that, the validation process shall consist on the identification of a set of indicators that are necessarily part of the process. For example: if the negotiation process is well understood by the involved actors; if the time reduction in the VO creation process is significant and leads to the aimed agility; and if the opinion of the involved actors in the process is positive.

Apart from the identification of the correct indicators to validate the process, a three level approach was adopted as a validation methodology:

— ***Validation in the research community***, considering:

- EU projects: integrating this research work on European research projects, can suggest the work validity allowing a simulation and test of case studies, and to formulate questionnaires to collect experts opinions; and

- Peer validation: assessing the proposed work through publications on relevant peer-reviewed international conferences, workshops, and journals. Also, direct interaction with existing networks with interest in such research work, namely the SOCOLNET/PRO-VE community that provided valuable assessment.

— ***Validation in a solar industry network***: aiming at gathering evidences of the general fitness of the proposed solutions in real scenarios; and

— ***Validation by comparison***: comparing the main proposed functionalities with available/emerging solutions in the market.

6.1 Validation in the Research Community

The validation in the research community was performed incrementally along the accomplishment of the proposed research work and provided a qualitative assessment of the work. As such, several scientific publications in recognized conferences and scientific journals were produced during the PhD work.

Also, international and national RTD projects provided valid sources of case studied and validation of the results. In addition, involvement in activities of the SOCOLNET society (*Society of Collaborative Networks: www.**socolnet**.org/*), provided a good interaction with peers and relevant stakeholders / experts in the application field, which provided important feedback on the course of the proposed research work.

6.1.1 Research Projects

The research work was developed in the *CoDIS group (Collaborative networks and Distributed Industrial Systems group) of CTS, Uninova* and in the *Electrical Engineering Department of Faculty of Sciences and Technology of Nova University of Lisbon*, which allowed a continuous integration in research projects. Thus, it is important to mention some of the group research projects that have contributed to support this work validation.

6.1.1.1 Validation in ECOLEAD

The ECOLEAD (*European Collaborative Networked Organizations LEADership initiative*) project provided a test-bed for the first design and development of the negotiation support environment for VO creation. Both the process and supporting tools for VO creation were designed and validated by four of the end-user networks involved in the project, namely: Swiss Microtech (Switzerland), ISOIN (Spain), CeBeNetwork

(Germany), and IECOS (Mexico). In a first stage, the tools for VO creation were individually evaluated by the end-users in a lab environment (trial phase) from which a positive feedback and suggestions for minor improvements were obtained. In a second phase, after refinements, integration, and customization, the end-users assessed the tools in their business scenarios with their real data (take-up phase, although in a "controlled" context).

One of the assessments made by Swiss Microtech had the main objective to verify if the VO creation process in an intercontinental context (Europe and China) could be accelerated reducing time in the VO set up through the usage of WizAN (Oliveira, et al., 2010). Specifically regarding the negotiation support environment, from this assessment the following conclusions were drawn (Galeano et al., 2008):

- The framework for VO creation increases effectiveness in terms of time and resources to react to a collaboration opportunity and the negotiation support environment has a fundamental role in the process;
- There is a clear usefulness of the negotiation environment in helping to guarantee the commitment of the potential partners;
- Reduction to about half of the time of the negotiation process;
- The templates usage in WizAN facilitate the composition of an initial agreement before the intervention of a lawyer, thus reducing time and cost;
- The negotiation support environment supports traceability of the negotiation process, keeping track of the partner's commitments and agreements. This aspect has particular relevance when dealing with different cultural contexts (e.g. Europe and China) to avoid misinterpretations ; and
- The work could lead to a future contribution to the ISO 9000 certification, as it ensures clearly defined and repeatable procedures.

6.1.1.2 Validation in GloNet

Two of the main objectives of the GloNet (*Glocal Enterprise Network Focusing on Customer-Centric Collaboration*) project were to support the creation of goal-oriented networks (VOs), and to support new business service design through co-creation teams. These objectives were completely achieved through the proposed research work, namely with the development of the:

- VO creation negotiation support environment through WizAN (as an improved and value added functionalities of the first version developed in the ECOLEAD project);
- Business service co-design negotiation support environment through CoDeN; and

— Electronic notary and registry support through e-Notary.

GloNet provided interactions with its end-users, namely iPLON (iPLON GmbH The Infranet Company, Germany) in the area of solar industry, and PROLON (Prolon Control Systems, Denmark) in the area of intelligent buildings. The end users provided an assessment of the "fitness-for-purpose" of the concepts and tools considering the requirements. The evaluation was based on structured questionnaires and feedback on the usage of the developed prototypes. Figure 6.1 illustrates part of the qualitative assessment by GloNet end users, considering the developed sub-systems for VO creation, which include the three environments proposed in this thesis: WizAN, CoDeN, and e-Notary.

As a general result of the assessment, end users found that the developed models and prototypes provided a good support for the collaboration requirements, although some improvements in the user interface style could be considered when evolving to a commercial product.

During GloNet, a dissemination event was performed in a workshop on *Factories of the Future* focused on *ICT trends in product and life-cycle management.* This workshop was held in Greece in November 2014 and the participants were mainly external (to GloNet) stakeholders. The stakeholders general opinion of WizAN, CoDeN and e-Notary was that the systems cope with the requirements and are useful in collaborative environments. Also, it was agreed that the multi-user environment provided by the negotiation systems is well structured and the information correctly represented.

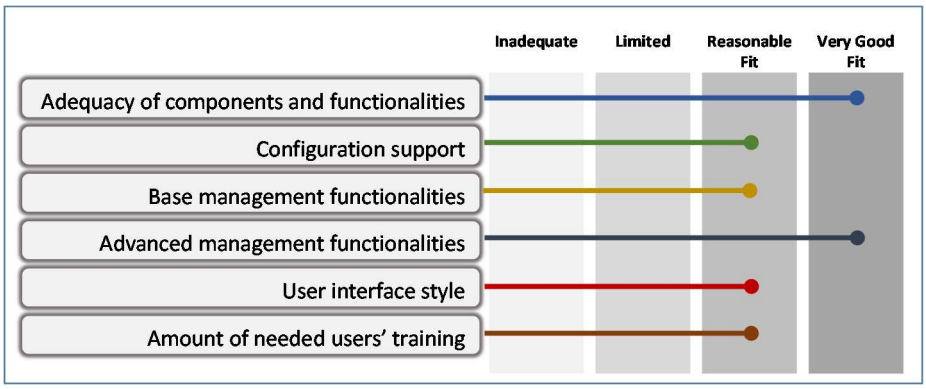

Figure 6.1. GloNet end-users qualitative evaluation

Also through the participation in the GloNet project, a more complete assessment by a solar energy network was carried out. More details of this assessment can be found below in section 6.2.

6.1.1.3 Validation in AAL4ALL

The main objective of the AAL4ALL (*Ambient Assisted Living for All*) project was to develop a large-scale ecosystem with products and ambient assisted living (AAL) services to support elderly people and maintain them at their preferred environments (Camarinha-Matos, et al., 2012a). This project considered as inputs results from the European FP7 research projects ePAL (*extending the Professional Active Life*) and BRAID (*Bridging Research in Ageing and ICT Development*), in which the author of this thesis also participated and contributed.

In this project, in the notion of ecosystem, there is also the concept of services composition by different stakeholders (Camarinha-Matos et al., 2014a). Therefore, the AAL4LL project, although not directly involved in the support and/or execution of the proposed research work, was to some extent important since it provided evidence that part of the work, namely the business service co-design negotiation environment was broad enough to support different and diverse contexts. CoDeN can then support the negotiation among different stakeholders in the co-design of new/emergent business AAL services.

6.1.2 Publications

Related to the proposed research work, a number of publications in recognized conference proceedings and scientific journals with the aim to obtain qualitative peer validation and to disseminate the research work were performed. In Annex F there is a list with publications related to the proposed work that includes: two publications in international journals; four publications as books chapters; and twenty publications in international conferences proceedings with peer reviewing.

6.2 Validation in a Solar Industry Network

With the purpose of confirming the general fitness of the developed solutions, an assessment of the proposed methodologies and tools, for negotiation during VO creation and BS co-design negotiation, with relevant stakeholders / experts in solar industry was made. For that, it was considered a network of partners that the GloNet partner iPLON GmbH has in India and which were not directly involved in the GloNet project. Fourteen stakeholders from this Indian network participated in this assessment. These stakeholders were all related to the solar industry, from components manufacturers, to monitoring systems developers.

Although it would be impossible to verify the real impact of the usage of WizAN, CoDeN and e-Notary during this thesis duration, the assessment strategy was to build a demonstrator based on a case study of the Charanka solar park in Gujarat, India, a contemporary project in which iPLON GloNet partner participated in the Operation and Maintenance system.

Figure 6.2. Charanka solar park, India

The construction process of this park was not supported by an ICT collaborative environment, thus most of the activities required a number of trips and face-to-face meetings with associated costs. If an ICT environment to support the process was available, a much more cost-effective process could have been followed, both in economic terms and in time spent.

Since this plant was mostly implemented through traditional methods used in the corresponding sector (mainly manual business processes), the idea was to replicate some of the business scenarios (Camarinha-Matos, et al., 2012b; Camarinha-Matos, et al., 2015b) including the three systems proposed in this thesis using the available data, acquired experience, and lessons learned. With this replication it was possible to compare the results against the traditional approaches that were actually used, and assess the potential impacts of adopting the proposed systems. To make a more accurate assessment, a brief demonstration of the main functionalities developed in the GloNet project was performed to the mentioned solar energy network, followed by a hands-on trial. This demonstration took place in Chennai, India in February 2015 and included the functionalities related to this thesis work, namely:

— Dynamic enterprise consortium creation to support the rapid formation of suitable collaborative networks, for operating during the various phases of the products' life-cycle, which included WizAN and e-Notary systems; and
— Co-creation/design negotiation support system supporting a group of stakeholders in the design of a new innovative business service based on the CoDeN system.

Figure 6.3. Validation event in Chennai, February 2015

According to the assessment made by the end-users, the collaboration support tools fit well the needs of the use case, although some improvements could naturally be considered when evolving to a commercial product. End users also estimated that although the needed organizational changes may be high, the expected potential benefits may also be very high.

To obtain a more complete evaluation, there was a closer interaction with two main stakeholders from the Indian network, lead users in the solar energy network.

6.2.1 Assessment by solar energy network

The experts opinion, from the solar energy network, were collected through structured questionnaires (Annex D). A synthesis of the assessment results are shown in Figure 6.4. As a general opinion, regarding the WizAN and e-Notary systems, there is a tendency for a high level of agreement. Nevertheless, probably due to the nature of the assessment (demonstrator with less interaction then a real usage would have), issues as stakeholders' roles and permissions were not uniformly agreed. In addition, as mentioned, regarding future commercial products it was suggested to invest on more intuitive user interfaces and support for mobile access. Furthermore, the combination of VBE and VO concepts in the WizAN system to support the VO creation was particularly appreciated.

For the co-creation use case, after some brainstorming among the involved stakeholders, the idea of a new service for a soiling loss system came up. Figure 6.5 illustrates the involved concepts for the scenario: the involved stakeholders, used templates, and ICT support system (CoDeN System).

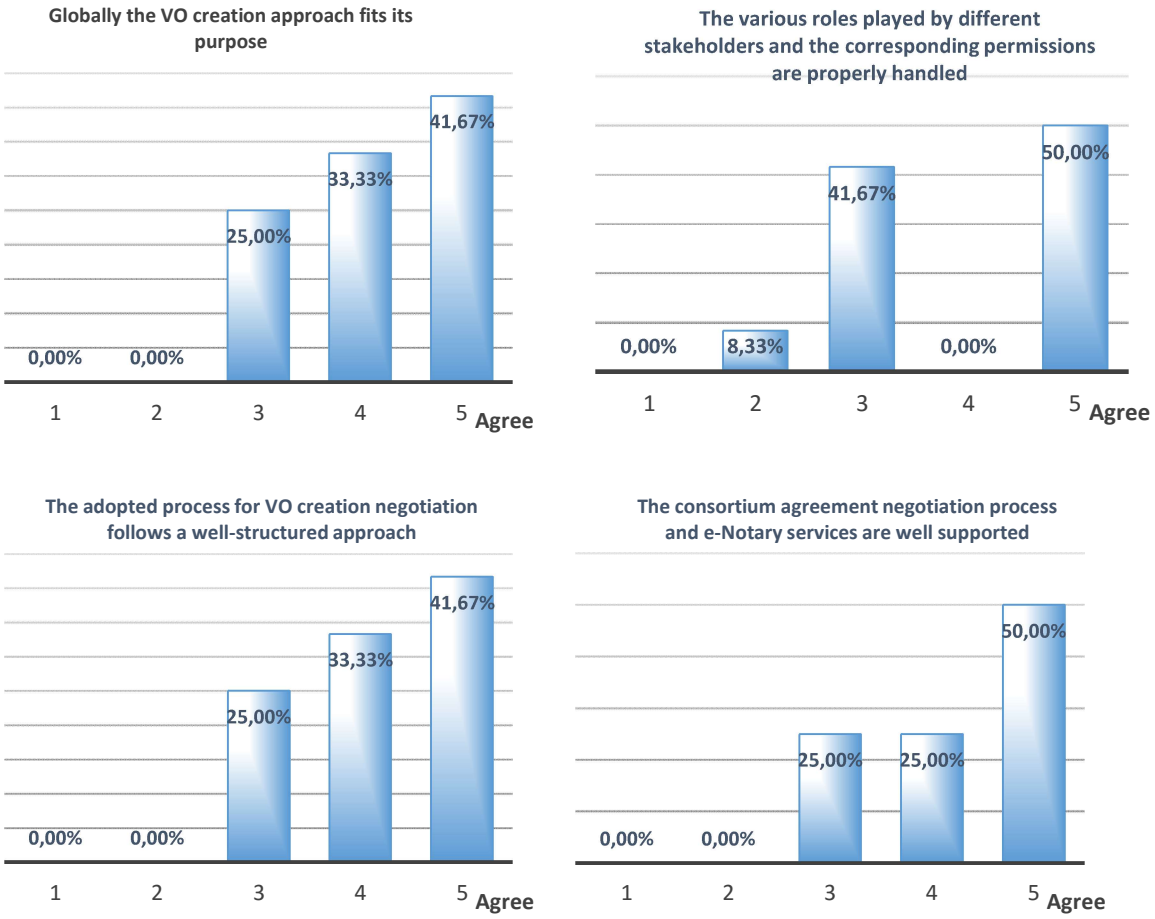

Figure 6.4. Assessment related to WizAN and e-Notary by the solar energy network

The agreements on the co-design of the new business service are reflected in an agreement, which is digitally signed by all involved stakeholders (an example can be found in Annex C). The final output of the system is a structured documentation set to support the development of the designed services.

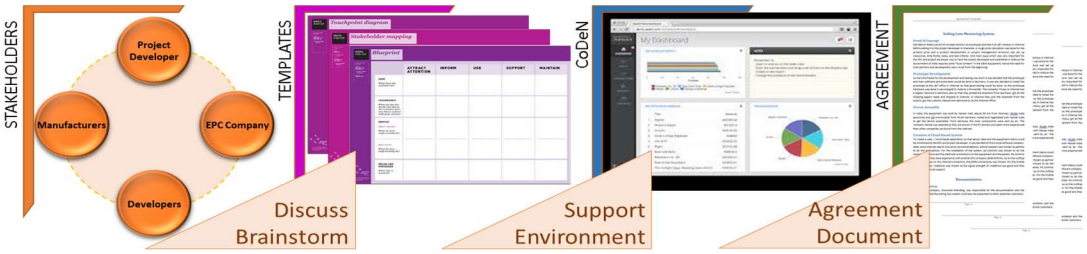

Figure 6.5. Example of Soiling Loss Measuring System Co-design

Once again, the experts opinions were collected through structured questionnaires (Annex D), and a synthesis of the assessment results is in shown Figure 6.6.

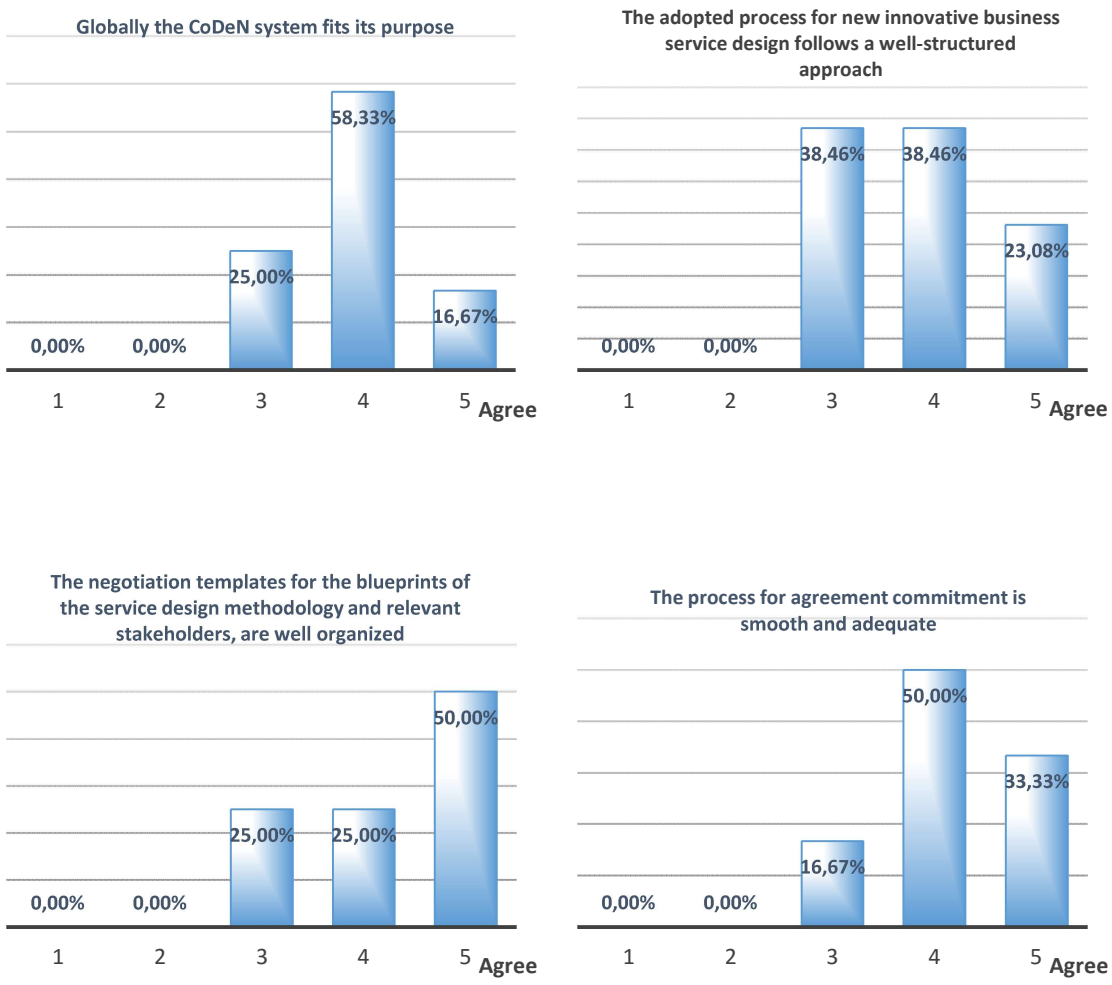

Figure 6.6. Assessment of CoDeN by the solar energy network

As a general opinion, regarding the usage of CoDeN it was well received. Nevertheless, once more due to the assessment nature, the followed approach and methodology in CoDeN could not be homogeneously agreed. Part of the noticed difficulty was the lack of background knowledge from the participants regarding collaborative networks. This could only be solved with specific training actions. In terms of a future commercial development, it is suggested to integrate Skype like tools.

6.2.2 Assessment by solar energy lead users

The opinions from the lead users of the solar energy network were collected through additional structured questionnaires (Annex E). This assessment considered five evaluation indicators, namely:

- Effort to acquire information: how the system behaves in the information retrieval;
- Confidentiality: how the system deals with users confidential data and permissions;
- Design suitability: how the system is designed to facilitate its usability;
- Presentation of the information: how the system provides the flow of information; and
- Fit for purpose: how the system accomplishes its purposes.

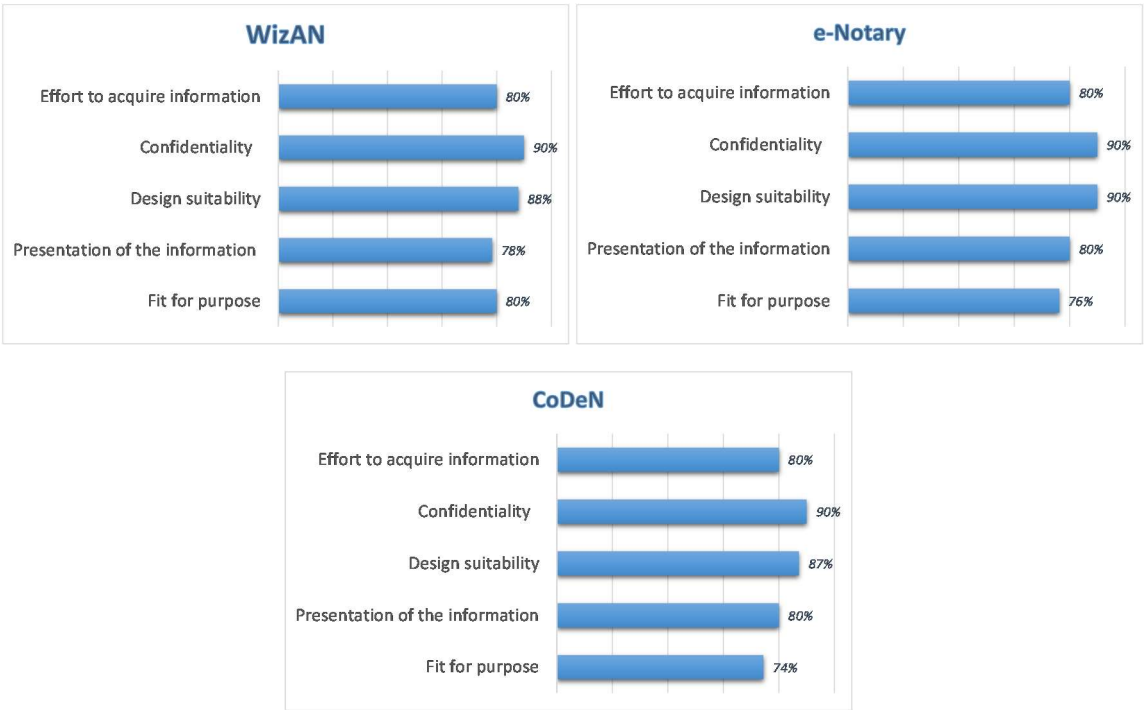

Figure 6.7. Assessment related to WizAN, e-Notary and CoDeN by the solar energy network lead users

A synthesis of the assessment results is in shown Figure 6.7. This assessment was considered positive for all three systems considering the evaluation indicators. Nevertheless, it shall be noted that the lead users are naturally biased by their current (traditional) practices not yet involving advanced collaboration in daily business, and thus had more difficulty in understanding novel tools, which implies a new mindset. On the other hand, this created the opportunity for very fruitful discussions about future

business models. Also, these lead users are based in India, and thus the assessment had to consider the local business and cultural context.

6.3 Comparison

In order to complement the validation process, a comparison analysis of the proposed functionalities for the VO creation negotiation support system, business service co-design system, and electronic notary and registry system with available/emerging solutions on the market was made. Taking into consideration the main requirements of the three systems, and comments from relevant stakeholders/experts, the main topics considered for comparison are described in Table 6.1.

Table 6.1. Topics considered for comparison with developed systems

Topic	*Description*
[F1]	Functionalities of negotiation support system to assist the VO planner and VO partners in the process of reaching agreements, including the proposed virtual negotiation spaces and negotiation templates management.
[F2]	Functionalities to enhance the consortium formation such as functionalities to reduce consortium's risks, with the assessment of partners' value system analysis and their levels of trustworthiness.
[F3]	Functionalities of electronic notary and registry system.
[F4]	Functionalities for achieving agreements in co-creation: the co-design of new business services using a service design methodology.

The adopted comparison approach is illustrated in Figure 6.8, and the main sources of information for collaboration platforms and software were based on web information search. For that, the list of the main keywords for Web information search were: *Collaborative platform configuration; Collaborative platform members profile management; Negotiation support system software; Generate consortium contract software;* and *Generate consortium agreement software*

These keywords provided several results containing collaboration platforms and software tools, but some of them were not suitable for comparison as their available functionalities were not related to the proposed solutions. Therefore, considering the most similar approaches, the results that were selected for comparison are summarized in Table 6.2:

Table 6.2. Approaches considered for comparison with developed systems

Approach	*Description*
[S1]	Confluence (Atlassian, 2015): collaboration platform for group discussions. It allows the manual creation of groups, group documents sharing with permissions, and the possibility to include add-ons of other tools (ex. Skype).
[S2]	Redbooth (Redbooth, 2015): collaboration platform for team work. It allows the manual creation of groups with file storage and can integrate with *Dropbox* and *Goggle Drive*.
[S3]	NBCBN-RE (Nile Basin Capacity Building Network) (NBCBN-RE, 2015): knowledge network with specific collaboration tools that include manual creation of workspaces for groups that can include chatting rooms to discuss online different issues related to their joint activities. Also shared workspaces are available for exchanging documentation.
[S4]	Collaboration Solutions (IBM, 2015): business collaboration software with enterprise social and email solutions. It allows team discussion with file sharing. Also messaging functionalities are available. Templates can be created to share information within communities.
[S5]	eXo Platform (eXo-Platform, 2015): enterprise social platform, which allows the manual creation of groups for teams or projects with available document sharing.
[S6]	Novatus (Novatus.Inc, 2015): cloud-based contract management software to assist in achieving contractual agreements. It comprises a manual assignment of members to projects that include the integration of contracts, contract drafting, and document negotiation. Templates can be created from a list of clause library. It also includes the integration of electronic signature.
[S7]	Optimus BT (OptimusBT, 2015): integrates *APP*s for the *Cloud*, *Office 365* and *Sharepoint* that enable manual assignment of members to projects. Contracts can be included and saved in document libraries as draft and final contracts. There is the possibility to create a custom contract with customized metadata. Electronic signature is also available
[S8]	Prodagio Software (Prodagio-Software, 2015): software application to assist customers in the management of their contracts. It allows the creation of contracts using automated template wizards that leverage *MSWord*. It provides a contract verification against a clause library for any non-standard contract clause or any high-risk language. It also integrates electronic signature solution.
[S9]	Binfire (Binfire, 2015): project management and collaboration application. It allows the creation of teams with manual invitation and a collaborative use of many applications for communication and collaboration, such as *Google* applications (*Drive*, *Calendar*, *Documents*, etc.), *Dashboards,* etc.
[S10]	iCoordinator (iCoordinator, 2015): collaborative document management. It allow a manual assignment of members to project planning.

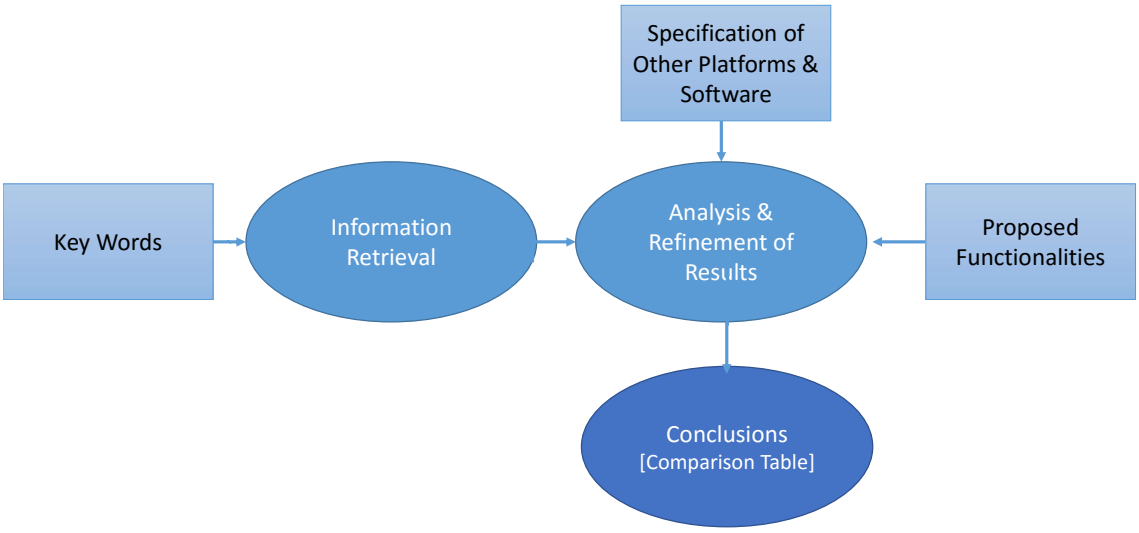

Figure 6.8. Comparison methodology of proposed functionalities with market solutions

Table 6.3 presents some comparison conclusions.

Table 6.3. Comparison of proposed functionalities with market solutions

	[S1]	[S2]	[S3]	[S4]	[S5]	[S6]	[S7]	[S8]	[S9]	[S10]
[F1]										
[F2]										
[F3]										
[F4]										

Functionalities strongly applies
Functionalities partially applies
Functionalities slightly applies
Functionalities do not apply

From Table 6.3, it can be concluded that although [S8] is the compared solution closer to the developed solutions, most of the competitive solutions do not provide an integrated environment for the VO creation negotiation support neither for BS co-design negotiation. The main reasons for such conclusion are:

- lack of list of potential consortia with ranking following an assessment of the potential consortium value system analysis and level of trustworthiness;
- lack of generation of templates for negotiation agreement establishment according to preferences in a collaborative context;

- lack of negotiation wizard with private negotiation spaces with documentation support and generation of corresponding agreement document;
- lack of integrated electronic notary and registry system to keep the negotiation agreement signed by all intervenient; and
- lack of co-creation environment to support service design methodology with documentation support and generation of negotiation agreement document (that can also be stored and signed through the e-Notary system).

Nevertheless, the author recognizes that this comparison was somehow superficial as it was only based on documentation available on the web and not based on hands-on experimentation.

6.4 Brief Summary

In section 1.2, the main research question was defined and decomposed into three sub-questions with corresponding hypotheses that led to a main hypothesis. Considering the followed validation methodology in this chapter, it can be concluded that the hypothesis has been positively validated.

The validation in the scientific community provided an overall peer assessment of the global work since several publications have been evaluated and accepted during the PhD work. Also the participation in European research projects provided positive assessment due to close interaction with end users both in ECOLEAD and GloNet projects. In a first phase, in ECOLEAD project, to support some of the concepts and basic functionalities, an agreement negotiation wizard (WizAN) was designed and developed (Oliveira and Camarinha-Matos, 2008; Oliveira, et al., 2010). The involved concepts and prototype aimed to assist the human users in their decision making process of consortia creation, structuring the negotiation process and making it traceable. Through interaction with some real VBE networks, the prototype was positively validated specially in a real scenario with a Swiss and a Chinese VBE, supporting negotiations among partners from the two geographical areas (Oliveira, et al., 2010). As a result, it is possible to draw some positive conclusions, namely in terms of preventing misunderstandings (particularly cultural) due to focused negotiation and the possibility to attach (electronic) documents, namely when comparing with traditional e-mail exchanges. Moreover, a degree of *authenticity* is also guaranteed due to the existence of an e-Notary service. Also, the system ensures the privacy of the information exchanged

during negotiations, guaranteeing that partners have access only to authorized information. Therefore, with such system, it is possible to reduce the negotiation time of the VO creation process, which increases the agility indicator, that gives support to both *Hypothesis 1* and *Hypothesis 2*. In a second phase, in GloNet project, a second version of WizAN was designed and developed (Oliveira and Camarinha-Matos, 2012, 2013, 2015). In this case, the collaboration risks were also considered, giving support to *Hypothesis 3*. In interaction with the project end users, the validation conclusions were consistent with the previous phase, but with emphasis on the fit-for-purpose of the tool. In this line, the same assessment was also made for CoDeN and e-Notary.

The validation by a solar energy network was accomplished to confirm the general fitness of the proposed solutions. Here the proposed solutions were globally accepted by end-users, highlighting that they offer SMEs the possibility of jointly having a more agile response in dynamic market conditions. Nevertheless, such solutions include functionalities that give a different perspective of the traditional ways of working of SMEs, and this certainly requires a change in the mind-set of companies operating in the solar energy sector, which are more used to sub-contracting relationships. Some less positive points and suggestions were mentioned, namely related to more intuitive user interfaces, and future commercial developments. Although aware of this fact, the outcomes of the proof-of-concept in the form of software prototypes, naturally lack some robustness and documentation expected in a commercial product. Therefore, it is not always easy for an evaluation team to keep this distinction in mind.

The validation by comparison analysis of the proposed functionalities of WizAN, CoDeN, and e-Notary with available or emerging solutions on the market was also made. Table 6.3 includes an analysis of that comparison and reflects that existing solutions do not provide an integrated environment for the VO creation negotiation, neither for the BS co-design negotiation, which are innovative contributions of this work.

7

Conclusions and Future Work

This chapter concludes this thesis. It presents the main topics and conclusions of the proposed research work. It includes an overview of the developed work, a summary of achieved results, and finalizes with some directions for future research.

7.1 Overview of the Work

The proposed research work started with the problem domain definition and motivation followed by the main research question that was decomposed into three research sub-questions. To guide the research process, a classical research methodology was followed. Through the background observation in the areas of: (i) collaborative networks; (ii) negotiation and contracting; (iii) business services; approaches for VO creation focusing on negotiation support are proposed to solve the research questions.

A VO creation process is proposed and designed to support the research work. The proposed process is not a totally individual work, but a result of a collaborative work, in which the author of this thesis participated as a major contributor, in both ECOLEAD and GloNet European research projects. Such process is described in chapter 3, contextualizing the recruitment spaces of VO partners, where the notion of *glocal* environment is introduced. Also, the actors and their dependencies, as well as a conceptual architecture are proposed. In the process of VO creation, the negotiation between partners is essential since it is how they reach agreements and commitments to regulate future collaboration. Due to geographical distribution of potential partners of a

VO, the use of electronic support for the negotiation process is essential. Therefore, in chapter 4 a negotiation support environment to assist the human users in achieving a VO agreement is proposed.

The negotiation support environment is then proposed and described with its main requirements and adopted negotiation protocol. A conceptual architecture is also introduced with five main modules, resulting in a framework called WizAN (agreement negotiation wizard). To address a different, but complementary, problematic of a business service co-design negotiation, the notion of co-creation network is defined. For this purpose, a negotiation support environment for business service co-design, following a service design methodology, is also proposed. The resulting environment is called CoDeN (services co-design negotiation environment). Both environments, WizAN and CoDeN, are supported by an electronic notary and registry system (e-Notary), to allow the digital signing of agreement documents, and exchange them with warranty of authenticity and validity.

To demonstrate the feasibility of the implementation of the three proposed systems (WizAN, CoDeN, and e-Notary), chapter 5 described the proof-of-concept software prototype implementation. The systems requirements are defined using UML use cases diagrams and their usability is demonstrated through some examples of use, guided by specific scenarios.

To validate the proposed work, in chapter 6 a three level approach was adopted as validation methodology that included: (i) validation in the research community; (ii) validation in a solar industry network; and (iii) validation by comparison analysis.

7.2 Results

Considering the main research question and the three decomposed sub-questions, the corresponding hypotheses were elaborated resulting on a main hypothesis. Through the development and validation of the proposed work, all hypotheses were validated. Figure 7.1 illustrates the followed research schema, including the main topics which contributed to the validation.

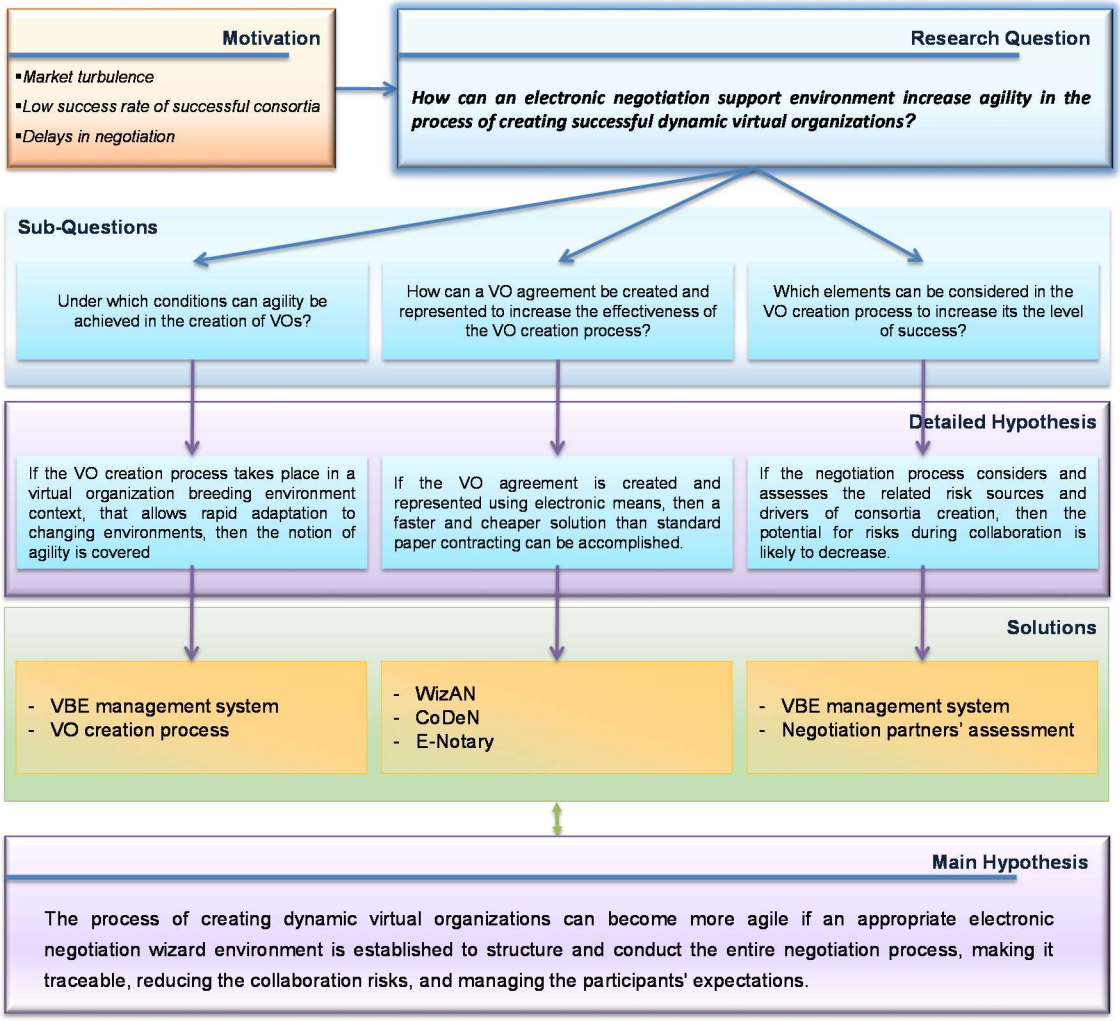

Figure 7.1. Research scheme

Through the various scenarios that were used both in ECOLEAD and GloNet European research projects and the validation in a solar energy network, some conclusions on the results of the proposed work may be drawn, and follows.

— **Focused negotiation**. During a VO creation a large number of topics typically need to be discussed and agreed by different partners. The diversity of "negotiation focus" can lead to loosing focus if the whole process is not properly organized. One contribution from this work, is that to conduct the necessary negotiations, both WizAN and CoDeN, support a structured solution, specifying the main part of the future agreement with the main characteristics of the product or service to be developed, and annex the necessary documents to support the corresponding technical specifications. WizAN supports both bilateral and multi-party negotiations and keeps the negotiation flows organized according to the various

VNSs, keeping the negotiation focus. In the same line, the CoDeN system uses a similar approach but with negotiation based on templates that follow a service design methodology.

— **Preventing misunderstandings.** In WizAN and CoDeN all negotiations and agreements reached during the negotiation phase are recorded and represented in the VO agreement, which contributes to reduce the risk of misunderstandings. The main supporting mechanisms are the possibility to keep track of the achieved commitments and agreements and their validation through the digital signature in the e-Notary system. An innovative aspect is the integration of e-Notary system functionalities with both WizAN and CoDeN.

— **Authenticity.** The existence of an e-Notary system is a mean to provide the exchange of agreement documents with a warranty of authenticity and validity as well as to provide them a safe repository.

— **Privacy.** In WizAN the privacy of the contents of VNSs is guaranteed. Although all potential VO partners have access to the general information and documentation of a VO, only the partners that are directly related to the negotiation topics are invited to participate in their discussions. A relevant aspect is the provision of confidentiality, since partners are not allowed to view discussions in which they are not involved. Thus, the exchange of information and documentation of each virtual negotiation space is private to its participants.

— **Time reduction.** By using traditional communication methods and tools to conduct a negotiation process, the delays are significantly long. Stakeholders pointed out that this fact is one of the main issues in consortia creation. Hence, with the usage of the proposed systems, the delays may be reduced. The main reason is due to their structured outline, that allows the VO planner and the co-creation team mediator to keep track of the chronology in which the negotiation is conducted. Thus, the VO planner can be alerted and proceed with other communication mechanisms and reminders if necessary. Nevertheless we only validated them in a "controlled environment".

7.3 Future Work

The obtained results of this thesis work indicate that the proposed solutions are relevant in the domains where the work has been developed and validated. Nevertheless there are open parts that give directions for future work. Some examples follow.

- **Negotiation with customer**. Revising and adapting the proposed methodologies and protocols to also include negotiation with customer in a VO creation. This case is of particular interest in the case of a bidding process.

- **More emphasis on collaboration risks**. Create a taxonomy for potential risks in collaboration and analyze how they can be directly related to potential participants' expectations and competences.

- **Level of automation.** Although the main focus should not be on an automated environment, some additional degrees of automation could be included in the process to assist the human users. As an example, in a virtual negotiation space the system could automatically verify and notify the user if the content that is being negotiated is in accordance with the objectives and values of the corresponding participant.

- **Different contexts.** Being the proposed solutions designed and developed for organizational contexts, namely networks of SMEs, depending on the domain the same approach might be adapted to other areas. Examples can be the negotiation on the development of a proposal for a research project; or the negotiation to obtain funding for research projects. Depending on the case, individual participants should also be considered.

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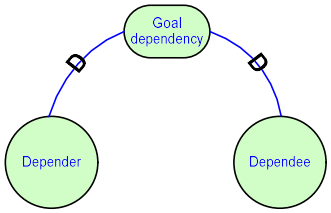
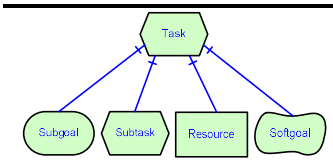
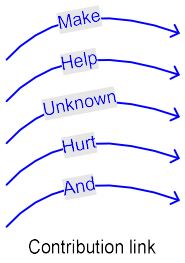
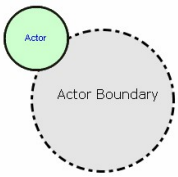
Annex A **Used Formalisms in Business Scenarios**

In addition to tables and textual descriptions, the following formalisms are adopted to help characterizing the business scenarios:

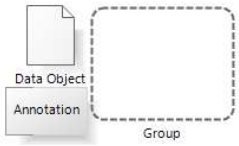
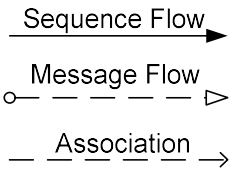
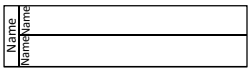
- i* (i-star) - to describe actors, goals, tasks, and their inter-relationships and/or dependencies. There are two main models:
  - strategic dependency model to identify the main relations and dependencies among actors;
  - strategic rational model to identify the actors' main internal goals and tasks.
- BPMN – to represent business processes.

Table A. 1. Main elements and concepts in i*

i* modeling	
	Active entities that carry out actions to achieve goals by exercising their know-how. The term actor generically refers to any unit to which intentional dependencies can be ascribed.
	(Hard Goal) Represents and intentional desire of an actor, the specifics of how the goal is to be satisfied is not described by the goal itself
	Soft goals are similar to (hard) goals, but their fulfillment cannot be defined precisely.
	One of the ways for the elements to achieve the goals is through the execution of specific tasks. A goal may be detailed / decomposed in a set of tasks.
	A physical or informational object that is available for use in the task.
	In a dependency link, the *depender* depends on the *dependee* to bring about a certain state of affairs in the world. The same dependency links can be established between tasks.
	A task can be decomposed into several other elements like a sub-goal, a sub-task, a resource or a soft-goal.
	A partial positive contribution, not sufficient by itself.
	Actor boundaries indicate intentional boundaries of a particular actor. All of the elements within a boundary of an actor are explicitly desired by that actor.

www.cs.toronto.edu/km/istar/

Table A. 2. Main concepts and formalisms in BPMN

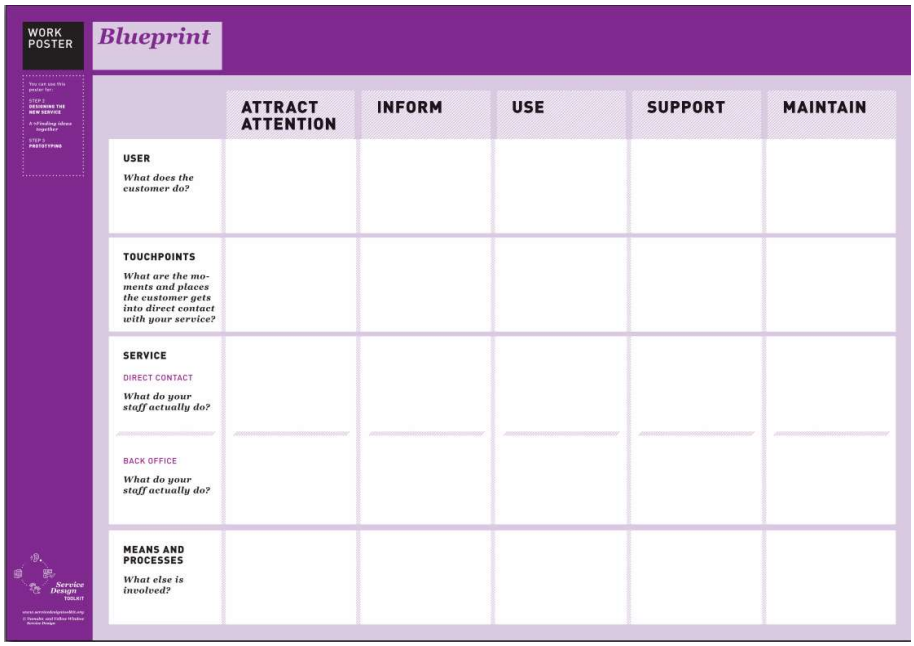
BPMN modeling	
	An activity is the work performed within a business process. It can be atomic or composite. It is used to model Tasks and sib-process and it can be iterative.
	An event is something that 'happens' in a process and affects its flow. It has either a trigger or a result and its boundaries determine the type of event.
	The gateway controls the sequence flow within a process at a point of divergence or convergence. In this way, gateways split and merge flows.
	Artifacts are not part of the process 'flow', nevertheless, they express information beyond the process itself. Like Data Objects, Groups, Annotations, etc..
	There are three main types of connectors: — 'Sequence Flow' to establish the order in which activities are performed. These connections can be established between events, activities and gateways. — 'Message Flow' to establish the low of messages between two entities. This connection is established between participants — 'Association' to associate data, information and artifacts with entities.
	Swimlanes identify the participants and their roles.

www.bizagi.com/docs/Introduction%20to%20BPMN.pdf

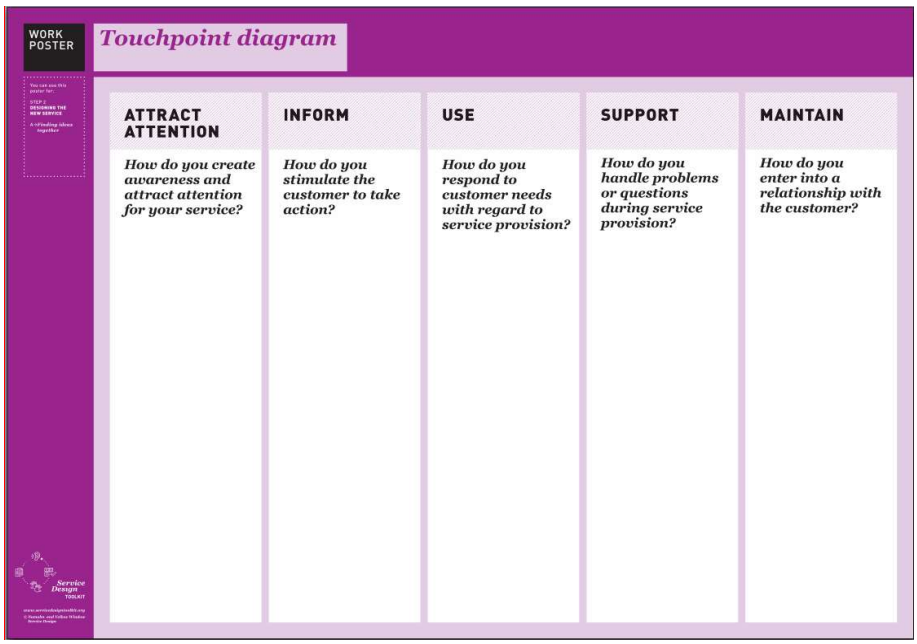
Annex B **Service Design Templates**

The figure below illustrate the adopted templates (Namahn and Window, 2013) that are used to reach consensus in CoDeN.

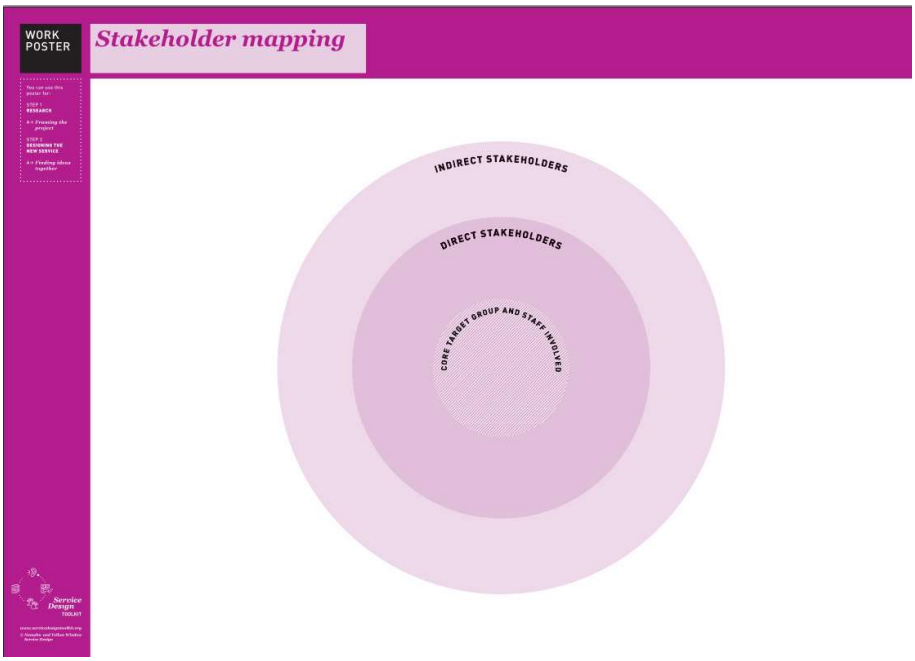
Blueprint:



Example of Touchpoint diagram:



Stakeholder mapping:



Annex C **Co-creation Agreement Example**

Agreement proposal document for:
String Monitoring;
Created on: Wed Feb 25 10:53:15 GMT 2015

SECTION 1 - SUMMARY

1.1 - Co-Creation Description:
Monitor production
Detect unexpected behaviour
Identify origin problem
Launch repair process
Report job completeness
Check operational status
1.2 - Co-Creation Sector:
solar
1.3 - Co-Creation Purpose:
Co-Creation

SECTION 2 - PARTICIPANTS

2.1 - Co-Creation Customer:
iPLON GmbH

SECTION 3 - DATES

3.1 - Co-Creation Starting Date:
2015-02-25
3.2 - Co-Creation Agreement Date:
3.3 - New Business Service Starting Date:
2015-03-19
3.4 - New Business Service Duration:
24 months

SECTION 4 - SUPPORTING DOCUMENTATION

4.1 - Supporting Documents:
Specification_Grid_Tie_SPV_plant.pdf;
GloNet-ServiceDesign_SolarPlants.pptx;

SECTION 5 - BLUEPRINTS

5.1 - User Blueprint:
Identification of the main actions of the business service user

User blueprint Closed on: 2015-02-25				
ATTRACT ATTENTION	**INFORM**	**USE**	**SUPPORT**	**MAINTAIN**
How to create awareness and attract attention for service .	*How to stimulate the customer to take action .*	*How to respond to customer needs with regard to service provision.*	*How to handle problems or questions during service provision .*	*How to enter into a relationship with the customer .*
Check relevant media Visit fairs to acquire information Join relevant communities	Evaluate and analyze indicators become conscious of needs	Monitoring & controlling of platform Check on operational status (access sensor data) Provide preferences React to unexpected events	Customer inquiry Respond in case of "customer malfunctioning" Evaluate if the support was suitable -> feedback	Passively provide assessment of satisfaction level

5.2 - Touchpoint Blueprint:
Identification of the main moments and places that the customer gets into direct contact with the business service

Touchpoints blueprint Closed on: 2015-02-25				
ATTRACT ATTENTION	**INFORM**	**USE**	**SUPPORT**	**MAINTAIN**
How to create awareness and attract attention for service .	*How to stimulate the customer to take action .*	*How to respond to customer needs with regard to service provision.*	*How to handle problems or questions during service provision .*	*How to enter into a relationship with the customer .*
Specialized websites Specialized magazines Direct marketing (address the customer directly) Solar fair (specialized events) Join relevant communities	Show statistics (in case is not a new service) Collection of promises with suitable indicators. E.g.: Time reaction Quality cost Demonstration and/or mockup of the system	Configuration? Periodic report Answering to exceptional situations Negotiation for complex interactions	Basic Support mechanisms Help desk Chats Forums Hotline Wiki "social media" for community of customers - >Plant Operator	Continuous identification of customer needs Identification of technological trends (to avoid being outdated compared with competitors) User friendliness Design "nice looking" platform Discounts on next services, birthday, etc.

5.3 - Service Direct Contact Blueprint:
Identification of the main actions of the business service staff that have a direct contact

Service Direct Contact blueprint Closed on: 2015-02-25				
ATTRACT ATTENTION	**INFORM**	**USE**	**SUPPORT**	**MAINTAIN**
How to create awareness and attract attention for service .	*How to stimulate the customer to take action .*	*How to respond to customer needs with regard to service provision.*	*How to handle problems or questions during service provision .*	*How to enter into a relationship with the customer .*
Promotional talks	Demonstration and presentation Convincing the customer Expose customer problem	Consulting Check infrastructure Contact in case of special event Forward information -> provide info reports	Consulting Answering Support related communication, e.g. emails	Direct communication with customer

5.4 - Service Back Office Blueprint:

Identification of the main actions of the business service staff that stays in back office

Sevice Back Office blueprint Closed on: 2015-02-25				
ATTRACT ATTENTION	**INFORM**	**USE**	**SUPPORT**	**MAINTAIN**
How to create awareness and attract attention for service .	*How to stimulate the customer to take action .*	*How to respond to customer needs with regard to service provision.*	*How to handle problems or questions during service provision .*	*How to enter into a relationship with the customer .*
Preparing content Identifying opportunities Develop demonstrators?	Preparing content Analyze needs and problems	Generate reports Customize system Platform operation Interaction with other providers of VO	Problem solving	Identification of customer needs Identifications of technologies Research and development Campaign management

5.5 - Means and Processes Blueprint:

How to enter into a relationship with the customer .

Means and Processes blueprint Closed on: 2015-02-25				
ATTRACT ATTENTION	**INFORM**	**USE**	**SUPPORT**	**MAINTAIN**
How to create awareness and attract attention for service .	*How to stimulate the customer to take action .*	*How to respond to customer needs with regard to service provision.*	*How to handle problems or questions during service provision .*	*How to enter into a relationship with the customer .*

Presentations Press releases Public relations Social activity within communities $	Demonstrators research	GloNet platform Legacy systems Processes (Repair, controlling, SW development, etc.)	Processes Support tickets system	CRM Research department Market research Customer surveys

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SECTION 6 - STAKEHOLDER MAPPING

6.1 - Stakeholder Mapping Description:

Identification and mapping of the relevant Stakeholders for the new business service

6.2 - Core Target Group and Staff Involved:

PV Industry

6.3 - Direct Stakeholders:

Customer = Plant Operator
Plant Owner
O&M operators
Repairing servicing providers
Manual service provider
Panel suppliers

6.4 - Indirect Stakeholders:

Governmental institutions
Energy supplier
Insurance companies
Recycling entities

Annex D **Solar Industry Network Assessment Questionnaires**

This annex contains the questionnaire that was filled in by:

- External users, in a workshop of factories of the future focusing on ICT trends in product life-cycle management, in which GloNet made a dissemnination of its results. This event was held in Greece in November 2014; and
- Solar network partners during the GloNet project event in Chennai, India in February 2015.

Since the GoNet project includes several results that were also assessed in this event, in this annex only an excerpt related to this thesis research work, namely WizAN, CoDeN and e-Notary, of the questionnaire is presented.

The questionnaire also includes a compilation of all the answers that were given.

Collaborative Networks Overview

1. Name of Company:		
2. Street Address:		**3.** Telephone:
P.O. Box:	City:	**4.** Fax:
Zip Code:	Country:	**5.** E-Mail:
6. Contact Person:		Title:
7. Legal Status (e.g. Partnership, Private Limited Company, Government Institution)		
8. Year Established:		**9.** Number of Employees:
10. Gross Annual Turnover :		**11.** Annual Export Turnover
12. Type of Business/Products: Manufacturer ☐ Sole Agent ☐ Supplier ☐		
13. Type of Business/Services/Work: Engineering ☐ Civil Work ☐ Governmental Institution ☐		
14. References (main customers, country, year and technical field of products, services or work):		
15. Overview on Collaborative network		
16. List of Products/Services/Work or combined Product Service Systems offered within the Collaborative network		

17. Desired Functionalities for Collaborative Network Support			
18. Further interest in GloNet results (Please mark your interest with a X)	Further GloNet SW evaluation	GloNet User meetings	Your wish

2. Dynamic Enterprise Consortium Formation

This functionality supports the rapid formation of suitable collaborative networks, for operating as virtual organisations (VO) during the product life-cycle.

	Disagree				Agree
	1	2	3	4	5
The implemented VBE (long-term) functionalities support and facilitate long-term cooperation among partners.			16.67 %	33.33 %	50.00 %
Globally the VO (short-term) formation system fits its purpose			25.00 %	33.33 %	41.67 %
The adopted process for dynamic enterprise consortia (VO) formation follows a well-structured approach.			25.00 %	33.33 %	41.67 %
The consortium agreement negotiation process and e-notary services are well supported.			25.00 %	25.00 %	50.00 %
The various roles played by different stakeholders and the corresponding permissions are properly handled by the VO formation system.		8.33 %	41.67 %		50.00 %
Which other improvements would you suggest regarding the collaborative enterprise networks support?	The ideas of VBE and VO are very good				

3.5 Co-Creation/Design Negotiation Support System

This functionality supports a group of relevant stakeholders in the design of a new innovative business processes using a service design methodology.

	Disagree				Agree
	1	2	3	4	5
Globally the Service Co-design negotiation support system fits its purpose			25.00 %	58.33 %	16.67 %
The adopted process for new innovative business service design follows a well-structured approach.			38.46 %	38.46 %	23.08 %
The negotiation templates for the blueprints of the service design methodology (user, touch points, service direct contact, service back office, and means and processes) and relevant stakeholders, are well organized			25.00 %	25.00 %	50.00 %
The process for agreement commitment is smooth and adequate			16.67 %	50.00 %	33.33 %

Note: the questionnaire included other sections related to the other parts of GloNet that were not contributed by this thesis.

Annex E **Solar Industry Network Lead Users Assessment Questionnaires**

This annex contains the questionnaire that was filled in by the solar network lead users during the GloNet project event in Chennai, India in February 2015.

Since the GoNet project includes several results that were also assessed in this event, in this annex only an excerpt related to this thesis research work, namely WizAN, CoDeN and e-Notary, of the questionnaire is presented.

Lead user 1

GloNet – lead user evaluation – Chennai 25 Feb 2015

1.1 Profile of lead-users

** description of service-enhanced complex products*
**description of stakeholders characteristics*
**description of collaborative network structure*

Abstract elements		use case 1:
Product	Complex (physical) product	Fund and equipment manufactur
	Long life-cycle	20 Years
	Business services	warranty for 2 years & Extended for AM
	Mass customization	Yes
Stakeholders	Product/project designers	NO
	Product manufacturers	Yes
	Service providers	Yes
	Support entities	Yes
	Customers and users	NO
Organizational structures	Strategic alliance /Manufacturers VBE	Yes
	Customer related community	NO
	Product development VE	Yes
	Product servicing VE	Yes

1.2 Lead-user Prozesse

PLC phase	Total	Main business process	Lead user 1	2	3	4	5	6	7	8	9	10
Pre 0		0.1 Call for tender	✓									
		0.2 Concept development					✓					
1st		1.1 Product design										✓
		1.2 Process design	✓									✓
2nd		2.1 Production										✓
		2.2 deployment										
3rd		3.1 Support					✓					
		3.2 upgrade					✓					

Table 1: main business processes per lead user

1.2 VO formation and operation support

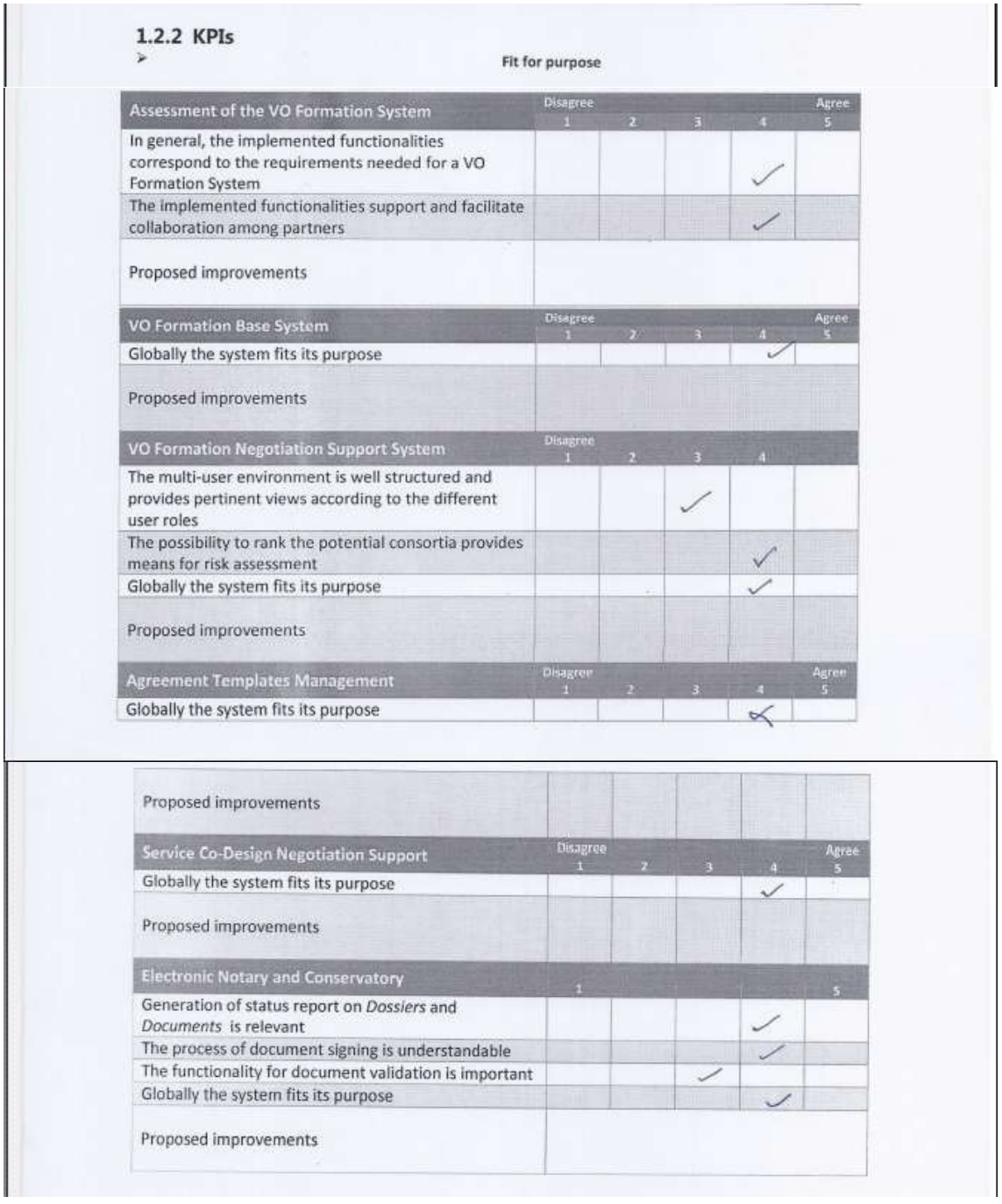
1.2.1 Overview

VBE Management System
The main purpose of the long-term base network (VBE – Virtual organizations Breeding Environment) is to promote preparedness of its members for collaboration. Therefore, the VBE Management System provides functionalities to manage the network and its members.

Main Functionalities	
VBE Information	VBE Member Information
VBE Profile	VBE Member Profile
VBE Performance Evaluations	VBE Member Performance Evaluations
VBE Values	VBE Member Values
VBE Competences	VBE Member Competences
VBE Member Registration	

VO Formation System
The main purpose of the VO Formation System is to boost the rapid formation of virtual organizations (VO). The main output is an agreement that can be used to regulate the behaviour and operational phase of the consortium. The system functionalities covers the entire VO formation process, from the interpretation of product/service specification according to the VBE Competences (summary of VBE Members competences) and correspondent identification of the most suitable VBE Members for the consortium, to the support on the VO agreement negotiation. Whenever new innovative business processes are required, a co-creation process can be carried out and a negotiation support tool for this case is also available. Also, functionalities to support both cases of negotiation, such as agreement template management system and an electronic and conservatory system, are included.

Main Functionalities	
VO Formation Base System	**VO Formation Negotiation Support System**
Interpretation of product/service specification	Risk assessment of potential consortia
Analysis of the VBE competences	Selection of the most suitable consortium
Matching with VBE members	Invitation of the most suitable partners
Creation of new VO general information	Attach relevant support documentation
Generation of potential consortia	Negotiation rooms for specific topics
	Creation of negotiation agreement
Electronic Notary and Conservatory	**Service Co-Design Negotiation Support**
Provide means for digitally sign documentation	Invitation of the most suitable partners
Assure privacy of documentation	Attach relevant support documentation
Manage history of documentation signatures	Negotiation rooms for service design methodology
	Creation of negotiation agreement
Verify if authenticity of documentation	**Agreement Templates Management**



1.2.2 KPIs

➢ Fit for purpose

Assessment of the VO Formation System	Disagree 1	2	3	4	Agree 5
In general, the implemented functionalities correspond to the requirements needed for a VO Formation System				✓	
The implemented functionalities support and facilitate collaboration among partners				✓	
Proposed improvements					

VO Formation Base System	Disagree 1	2	3	4	Agree 5
Globally the system fits its purpose				✓	
Proposed improvements					

VO Formation Negotiation Support System	Disagree 1	2	3	4	
The multi-user environment is well structured and provides pertinent views according to the different user roles			✓		
The possibility to rank the potential consortia provides means for risk assessment				✓	
Globally the system fits its purpose				✓	
Proposed improvements					

Agreement Templates Management	Disagree 1	2	3	4	Agree 5
Globally the system fits its purpose				✓	

Proposed improvements					

Service Co-Design Negotiation Support	Disagree 1	2	3	4	Agree 5
Globally the system fits its purpose				✓	
Proposed improvements					

Electronic Notary and Conservatory	1				5
Generation of status report on *Dossiers* and *Documents* is relevant				✓	
The process of document signing is understandable				✓	
The functionality for document validation is important			✓		
Globally the system fits its purpose				✓	
Proposed improvements					

➢ **Presentation of the information**

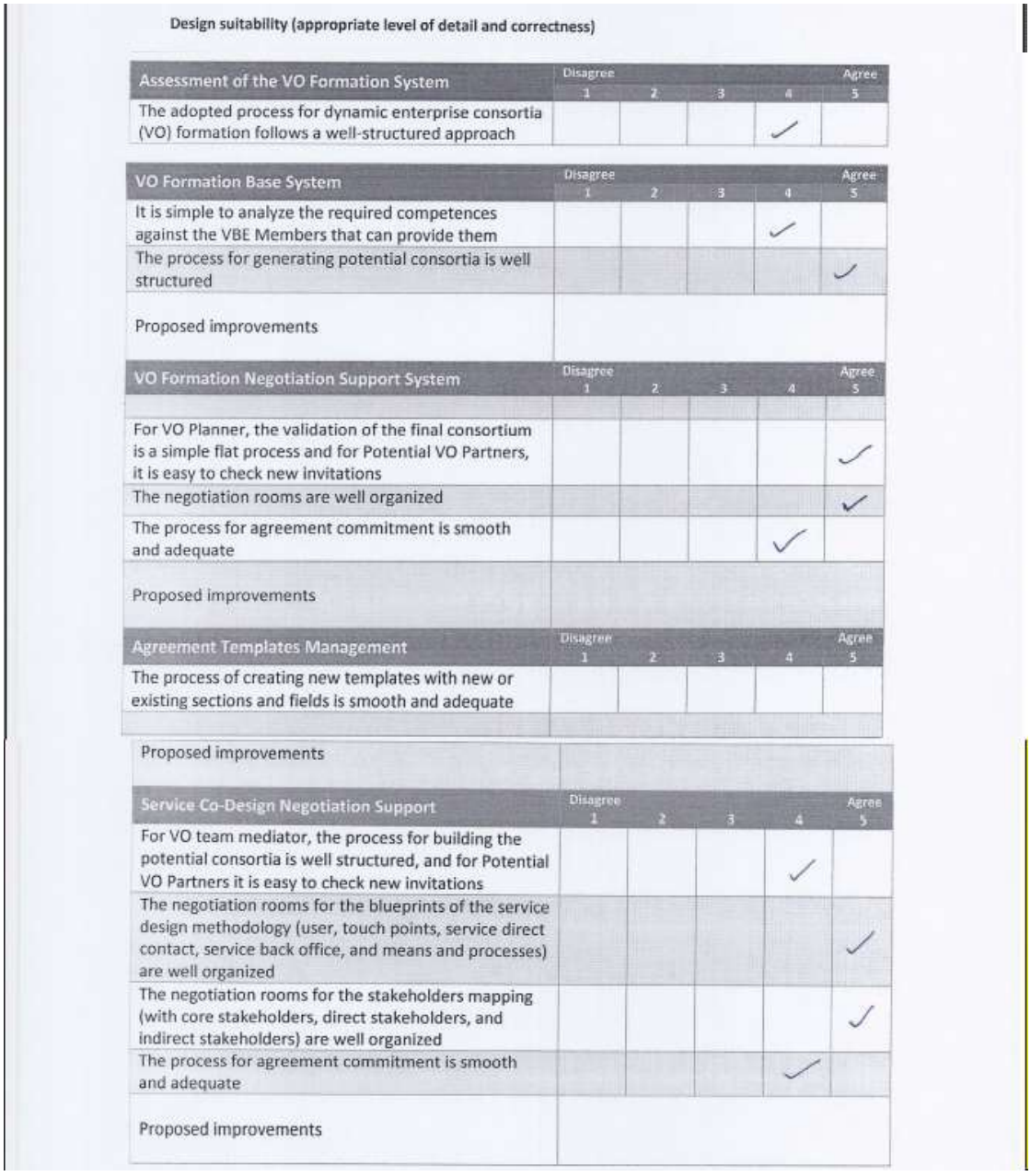
VO Formation Base System	Disagree 1	2	3	4	Agree 5
The information for order characterization is properly represented			✓		
The user interface allows a smooth and simple visualization and navigation through the implemented functionalities				✓	
The usability of the system is adequate				✓	
Proposed improvements					

VO Formation Negotiation Support System	1				5
The usability of the system is adequate				✓	
The user interface allows a smooth and simple visualization and navigation through the implemented functionalities				✓	
Proposed improvements					

Agreement Templates Management	Disagree 1	2	3	4	Agree 5
The usability of the system is adequate					
The user interface allows a smooth and simple visualization and navigation through the implemented functionalities					
Proposed improvements					

Service Co-Design Negotiation Support	Disagree 1	2	3	4	Agree 5
The information that characterizes the main requirements for the co-creation of a new business service is properly represented			✓		
The usability of the system is adequate				✓	
The user interface allows a smooth and simple visualization and navigation through the implemented functionalities				✓	
Proposed improvements					

Electronic Notary and Conservatory	Disagree 1	2	3	4	Agree 5
The information structure maintained by the e-Notary is adequate				✓	
The usability of the system is adequate				✓	
The user interface allows a smooth and simple visualization and navigation through the implemented functionalities				✓	
Proposed improvements					



Design suitability (appropriate level of detail and correctness)

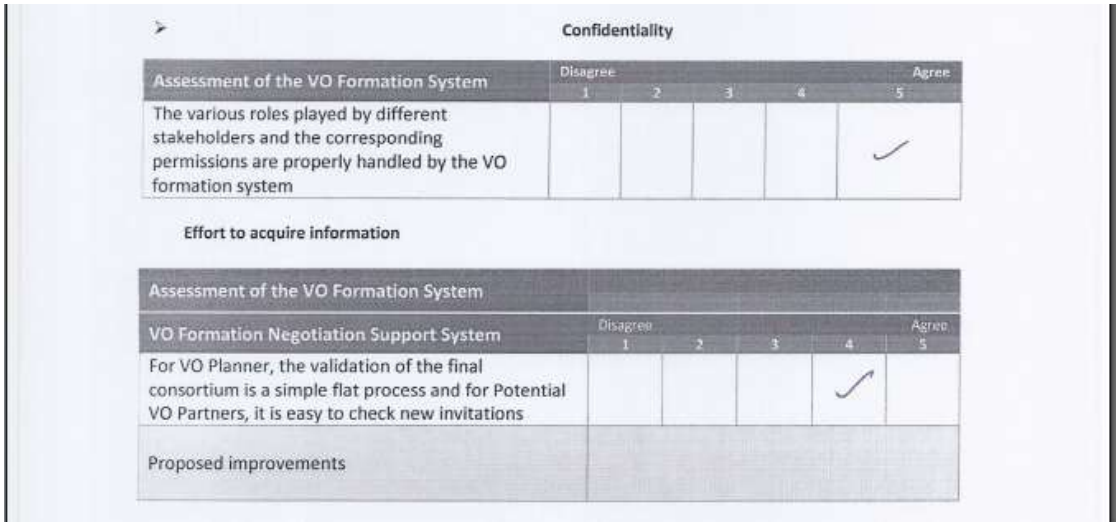
Assessment of the VO Formation System	Disagree 1	2	3	4	Agree 5
The adopted process for dynamic enterprise consortia (VO) formation follows a well-structured approach				✓	

VO Formation Base System	Disagree 1	2	3	4	Agree 5
It is simple to analyze the required competences against the VBE Members that can provide them				✓	
The process for generating potential consortia is well structured					✓
Proposed improvements					

VO Formation Negotiation Support System	Disagree 1	2	3	4	Agree 5
For VO Planner, the validation of the final consortium is a simple flat process and for Potential VO Partners, it is easy to check new invitations					✓
The negotiation rooms are well organized					✓
The process for agreement commitment is smooth and adequate				✓	
Proposed improvements					

Agreement Templates Management	Disagree 1	2	3	4	Agree 5
The process of creating new templates with new or existing sections and fields is smooth and adequate					
Proposed improvements					

Service Co-Design Negotiation Support	Disagree 1	2	3	4	Agree 5
For VO team mediator, the process for building the potential consortia is well structured, and for Potential VO Partners it is easy to check new invitations				✓	
The negotiation rooms for the blueprints of the service design methodology (user, touch points, service direct contact, service back office, and means and processes) are well organized					✓
The negotiation rooms for the stakeholders mapping (with core stakeholders, direct stakeholders, and indirect stakeholders) are well organized					✓
The process for agreement commitment is smooth and adequate				✓	
Proposed improvements					



➢ **Confidentiality**

Assessment of the VO Formation System	Disagree 1	2	3	4	Agree 5
The various roles played by different stakeholders and the corresponding permissions are properly handled by the VO formation system					✓

Effort to acquire information

Assessment of the VO Formation System					
VO Formation Negotiation Support System	Disagree 1	2	3	4	Agree 5
For VO Planner, the validation of the final consortium is a simple flat process and for Potential VO Partners, it is easy to check new invitations				✓	
Proposed improvements					

Lead user 2

GloNet – lead user evaluation – Chennai 25 Feb 2015

1.1 Profile of lead-users

** description of service-enhanced complex products*
**description of stakeholders characteristics*
**description of collaborative network structure*

Abstract elements		use case 1:
Product	Complex (physical) product	SPV Power Plants.
	Long life-cycle	25 years.
	Business services	Design, Commissioning & O&M of Power Plants
	Mass customization	yes.
Stakeholders	Product/project designers	✓
	Product manufacturers	✓
	Service providers	✓
	Support entities	✓
	Customers and users	✓
Organizational structures	Strategic alliance /Manufacturers VBE	Long Term.
	Customer related community	yes.
	Product development VE	
	Product servicing VE	yes.

1.2 Lead-user Prozesse

PLC phase	*Total*	*Main business process*	*Lead user* 1	2	3	4	5	6	7	8	9	*10*
Pre		0.1 Call for tender	✓									
0		0.2 Concept development										✓
1st		1.1 Product design										✓
		1.2 Process design										✓
2nd		2.1 Production										✓
		2.2 deployment										✓
3rd		3.1 Support										✓
		3.2 upgrade										✓

Table 1: main business processes per lead user

1.2 VO formation and operation support

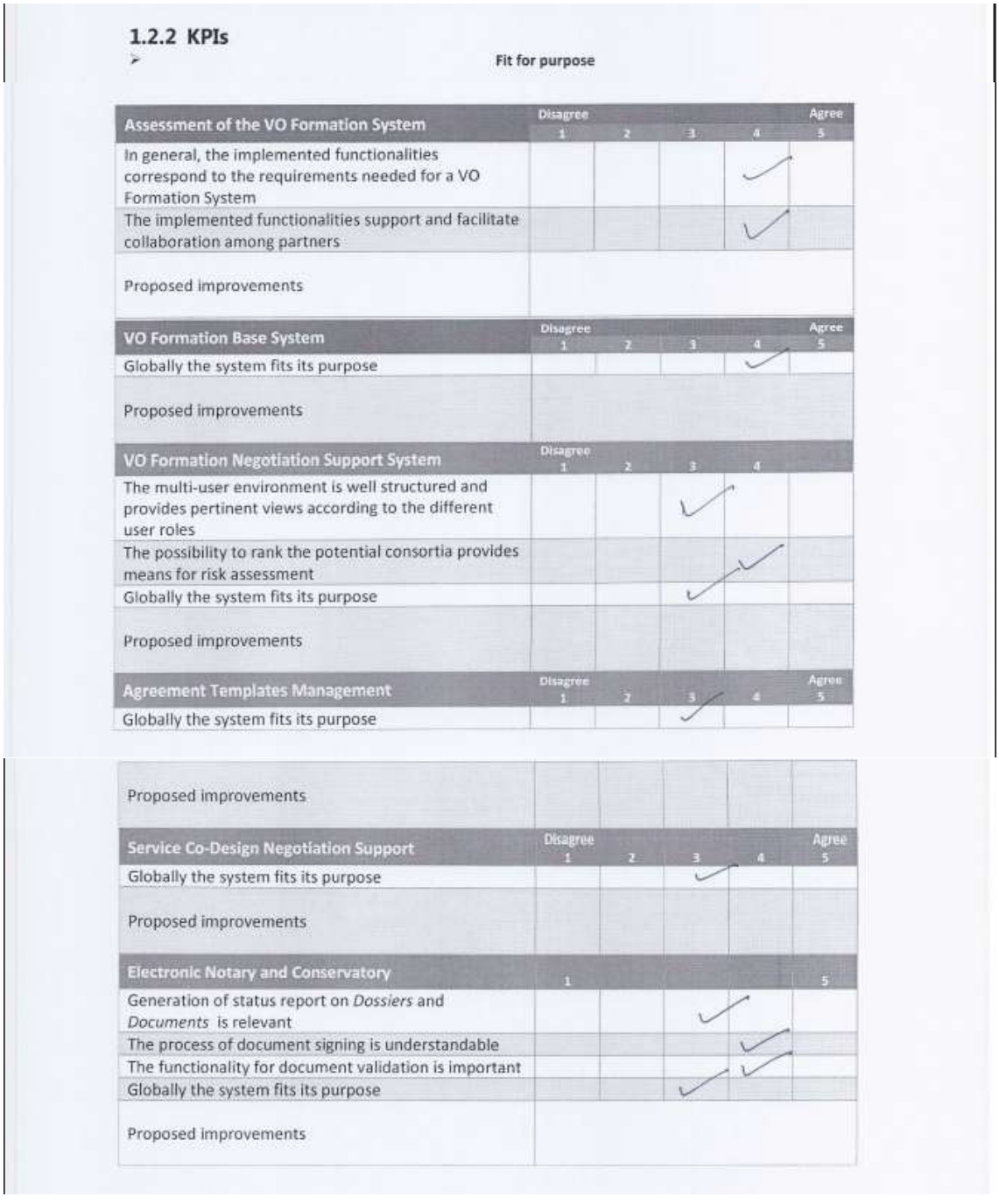
1.2.1 Overview

VBE Management System
The main purpose of the long-term base network (VBE – Virtual organizations Breeding Environment) is to promote preparedness of its members for collaboration. Therefore, the VBE Management System provides functionalities to manage the network and its members.

Main Functionalities	
VBE Information	VBE Member Information
VBE Profile	VBE Member Profile
VBE Performance Evaluations	VBE Member Performance Evaluations
VBE Values	VBE Member Values
VBE Competences	VBE Member Competences
VBE Member Registration	

VO Formation System
The main purpose of the VO Formation System is to boost the rapid formation of virtual organizations (VO). The main output is an agreement that can be used to regulate the behaviour and operational phase of the consortium. The system functionalities covers the entire VO formation process, from the interpretation of product/service specification according to the VBE Competences (summary of VBE Members competences) and correspondent identification of the most suitable VBE Members for the consortium, to the support on the VO agreement negotiation. Whenever new innovative business processes are required, a co-creation process can be carried out and a negotiation support tool for this case is also available. Also, functionalities to support both cases of negotiation, such as agreement template management system and an electronic and conservatory system, are included.

Main Functionalities	
VO Formation Base System	**VO Formation Negotiation Support System**
Interpretation of product/service specification	Risk assessment of potential consortia
Analysis of the VBE competences	Selection of the most suitable consortium
Matching with VBE members	Invitation of the most suitable partners
Creation of new VO general information	Attach relevant support documentation
Generation of potential consortia	Negotiation rooms for specific topics
	Creation of negotiation agreement
Electronic Notary and Conservatory	**Service Co-Design Negotiation Support**
Provide means for digitally sign documentation	Invitation of the most suitable partners
Assure privacy of documentation	Attach relevant support documentation
Manage history of documentation signatures	Negotiation rooms for service design methodology
	Creation of negotiation agreement
Verify if authenticity of documentation	**Agreement Templates Management**



1.2.2 KPIs

➢ **Fit for purpose**

Assessment of the VO Formation System	Disagree 1	2	3	4	Agree 5
In general, the implemented functionalities correspond to the requirements needed for a VO Formation System				✓	
The implemented functionalities support and facilitate collaboration among partners				✓	
Proposed improvements					

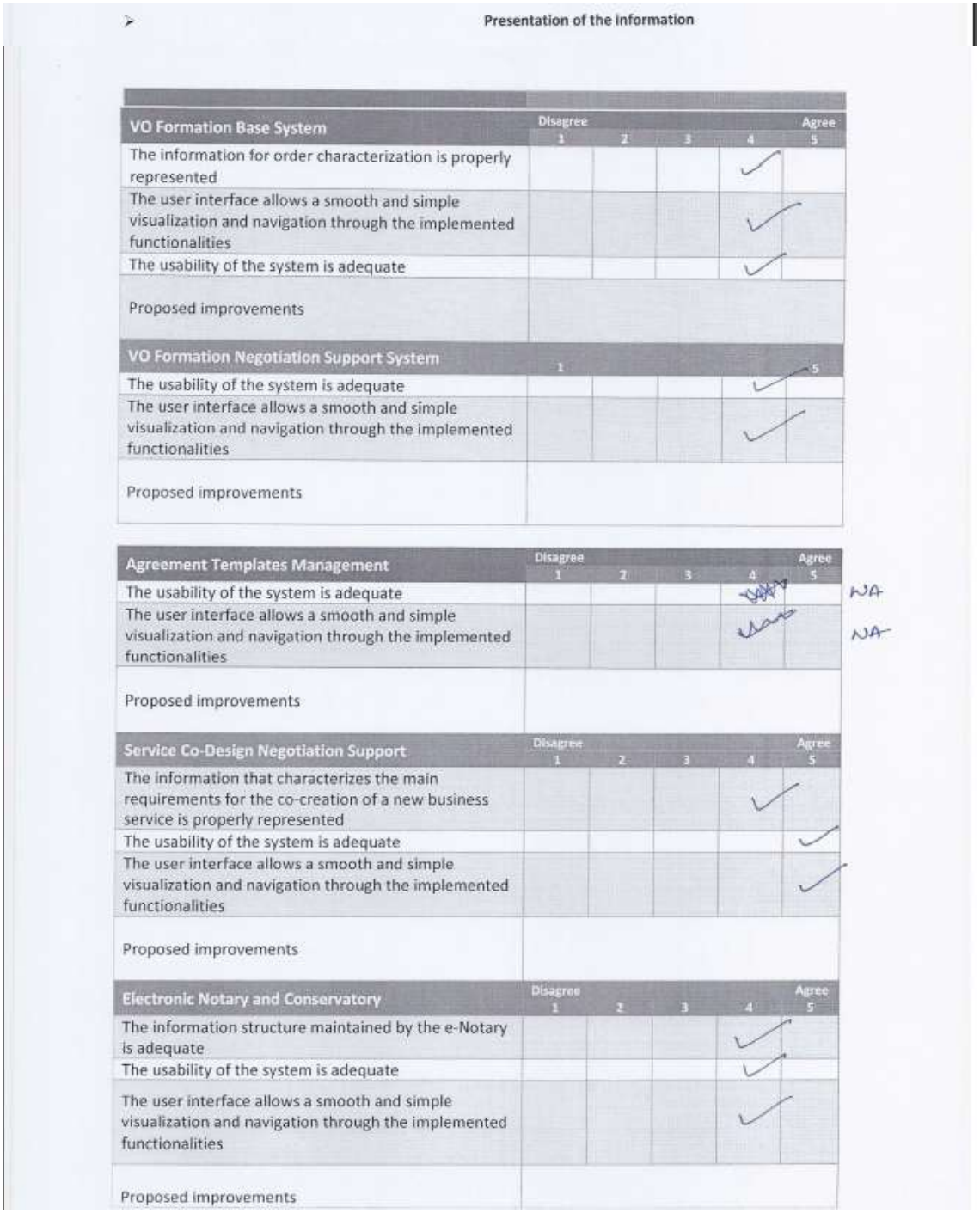
VO Formation Base System	Disagree 1	2	3	4	Agree 5
Globally the system fits its purpose				✓	
Proposed improvements					

VO Formation Negotiation Support System	Disagree 1	2	3	4
The multi-user environment is well structured and provides pertinent views according to the different user roles			✓	
The possibility to rank the potential consortia provides means for risk assessment				✓
Globally the system fits its purpose			✓	
Proposed improvements				

Agreement Templates Management	Disagree 1	2	3	4	Agree 5
Globally the system fits its purpose			✓		
Proposed improvements					

Service Co-Design Negotiation Support	Disagree 1	2	3	4	Agree 5
Globally the system fits its purpose			✓		
Proposed improvements					

Electronic Notary and Conservatory	1				5
Generation of status report on *Dossiers* and *Documents* is relevant			✓		
The process of document signing is understandable				✓	
The functionality for document validation is important				✓	
Globally the system fits its purpose			✓		
Proposed improvements					



➢ **Presentation of the information**

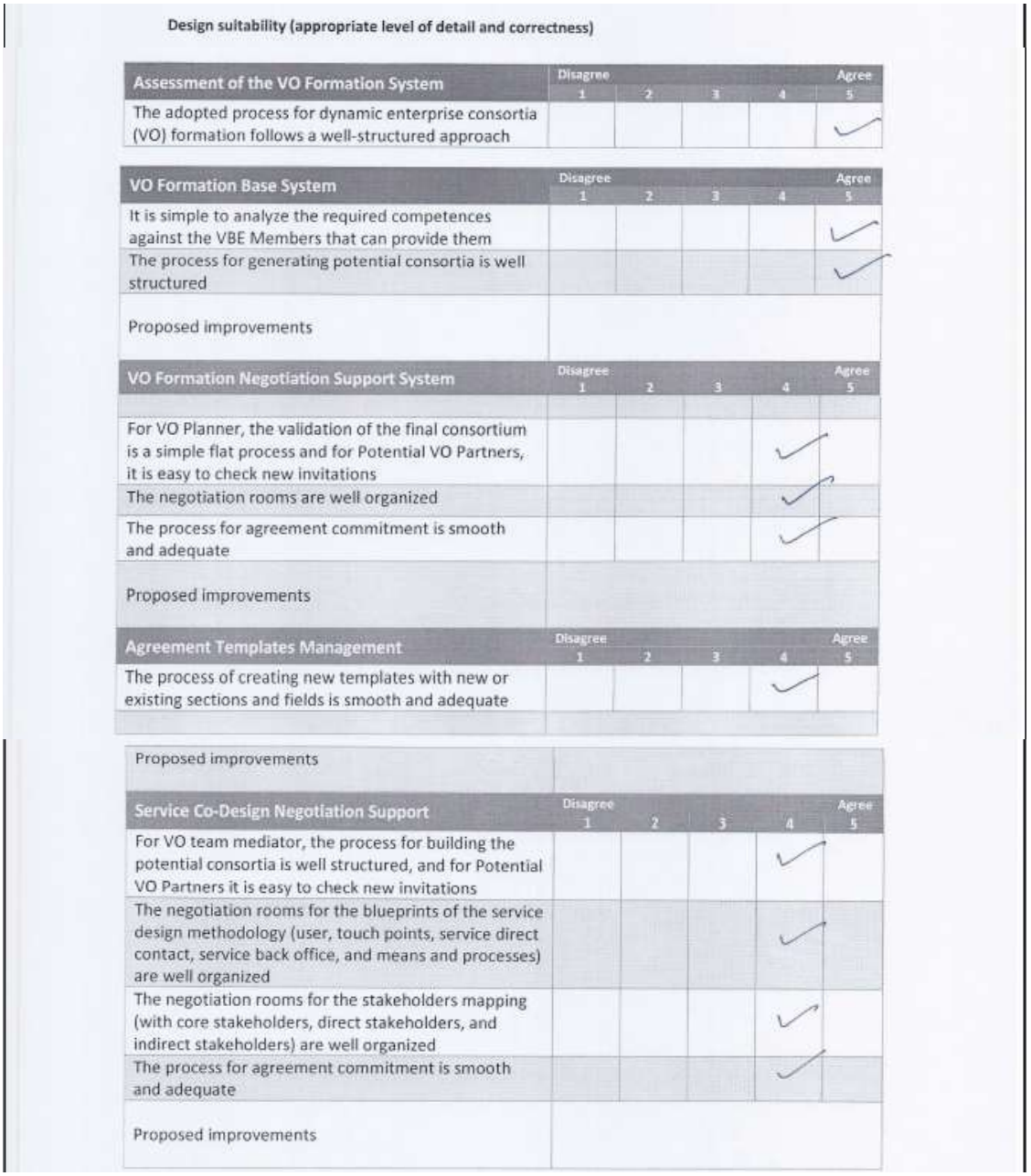
VO Formation Base System	Disagree 1	2	3	4	Agree 5
The information for order characterization is properly represented				✓	
The user interface allows a smooth and simple visualization and navigation through the implemented functionalities				✓	
The usability of the system is adequate				✓	
Proposed improvements					

VO Formation Negotiation Support System	1				5
The usability of the system is adequate				✓	
The user interface allows a smooth and simple visualization and navigation through the implemented functionalities				✓	
Proposed improvements					

Agreement Templates Management	Disagree 1	2	3	4	Agree 5	
The usability of the system is adequate				~~✓~~		NA
The user interface allows a smooth and simple visualization and navigation through the implemented functionalities				✓		NA
Proposed improvements						

Service Co-Design Negotiation Support	Disagree 1	2	3	4	Agree 5
The information that characterizes the main requirements for the co-creation of a new business service is properly represented				✓	
The usability of the system is adequate					✓
The user interface allows a smooth and simple visualization and navigation through the implemented functionalities					✓
Proposed improvements					

Electronic Notary and Conservatory	Disagree 1	2	3	4	Agree 5
The information structure maintained by the e-Notary is adequate				✓	
The usability of the system is adequate				✓	
The user interface allows a smooth and simple visualization and navigation through the implemented functionalities				✓	
Proposed improvements					



Design suitability (appropriate level of detail and correctness)

Assessment of the VO Formation System	Disagree 1	2	3	4	Agree 5
The adopted process for dynamic enterprise consortia (VO) formation follows a well-structured approach					✓

VO Formation Base System	Disagree 1	2	3	4	Agree 5
It is simple to analyze the required competences against the VBE Members that can provide them					✓
The process for generating potential consortia is well structured					✓
Proposed improvements					

VO Formation Negotiation Support System	Disagree 1	2	3	4	Agree 5
For VO Planner, the validation of the final consortium is a simple flat process and for Potential VO Partners, it is easy to check new invitations				✓	
The negotiation rooms are well organized				✓	
The process for agreement commitment is smooth and adequate				✓	
Proposed improvements					

Agreement Templates Management	Disagree 1	2	3	4	Agree 5
The process of creating new templates with new or existing sections and fields is smooth and adequate				✓	
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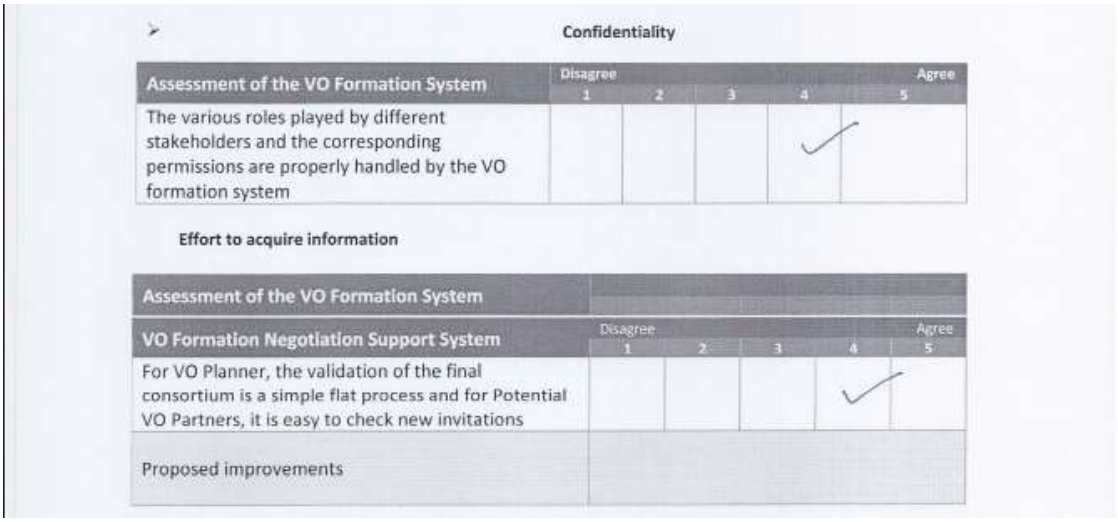
The negotiation rooms for the stakeholders mapping (with core stakeholders, direct stakeholders, and indirect stakeholders) are well organized				✓	
The process for agreement commitment is smooth and adequate				✓	
Proposed improvements					



Confidentiality

Assessment of the VO Formation System	Disagree 1	2	3	4	Agree 5
The various roles played by different stakeholders and the corresponding permissions are properly handled by the VO formation system				✓	

Effort to acquire information

Assessment of the VO Formation System					
VO Formation Negotiation Support System	Disagree 1	2	3	4	Agree 5
For VO Planner, the validation of the final consortium is a simple flat process and for Potential VO Partners, it is easy to check new invitations				✓	
Proposed improvements					

Note: the questionnaire included other sections related to the other parts of GloNet that were not contributed by this thesis.

Annex F List of Publications Related to the Proposed Work

Publications in International Journals	
1	A framework for computer-assisted creation of dynamic virtual organizations, *L.M. Camarinha-Matos, A.I. Oliveira, M. Sesana, N. Galeano, D. Demsar, F. Baldo, T. Jarimo. International Journal of Production Research, Vol 47, Issue 17, pp.4661 – 4690,* 2009.
2	Agreement negotiation support in VO creation – an illustrative case, *A.I. Oliveira, L.M. Camarinha-Matos, M. Pouly. Journal of Production Planning and Control, Vol. 21, No. 2, pp.160–180,* 2010.

Books Chapters	
1	Contract negotiation wizard for VO creation, *L.M. Camarinha-Matos, A.I. Oliveira, in Digital enterprise technology – Perspectives and challenges (Eds.: P. Cunha, P. Maropoulos), Springer, pp.333-342,* 2007.
2	VO Creation assistance services, *L.M. Camarinha-Matos, A.I. Oliveira, D. Demstar, M. Sesana, A. Molina, F. Baldo, T. Jarimo, in Methods and tools for Collaborative Networked Organizations, (Eds.: L.M. Camarinha-Matos, H. Afsarmanesh, M. Ollus), Springer, pp.155-190*, 2008.
3	Agreement negotiation wizard, *A.I. Oliveira, L.M. Camarinha-Matos, in Methods and tools for Collaborative Networked Organizations, (Eds.: L.M. Camarinha-Matos, H. Afsarmanesh, M. Ollus), Springer, pp.191-218,* 2008.
4	Cloud-based Collaborative Business Services Provision, *L.M. Camarinha-Matos, H. Afsarmanesh, A.I. Oliveira and F. Ferrada, in Enterprise Information Systems, Lecture Notes on Business Information Processing, Springer International Publishing, pp 366-384,* 2014.

	Publications in International Conferences Proceedings
1	Towards a framework for creation of dynamic virtual organizations, *L.M. Camarinha-Matos, I. Silveri, H. Afsarmanesh, A. I. Oliveira, in Proceedings of PRO-VE'05 – Collaborative Networks and their Breeding Environments, 6th IFIP TC5 WG 5.5 Working Conference on Virtual Enterprises, Valencia, Spain, September 26–28, 2005, Springer IFIP Series Volume 186, pp.69-80,* 2005.
2	Contract negotiation wizard for VO creation, *L.M. Camarinha-Matos, A.I. Oliveira, in Proceedings of DET'06 - Perspectives and Future Challenges, 3rd International CIRP Conference in Digital Enterprise Technology, Sesimbra, Portugal, September 18-20, 2006, Springer, pp. 333-342,* 2006.
3	A computer-assisted VO creation framework, *L.M. Camarinha-Matos, A.I Oliveira, R. Ratti, D. Demsar, F. Baldo, T. Jarimo, , in Proceedings of PRO-VE'07 – Establishing the foundation of collaborative networks, 8th IFIP TC5 WG 5.5 Working Conference on Virtual Enterprises, Guimarães, Portugal, September 10–12, 2005, Springer IFIP Series Volume 243, pp.165-178,* 2007.
4	Agreement negotiation support in VO creation, *A. I. Oliveira, L. M. Camarinha-Matos, M. Pouly, in Proceedings of PRO-VE'08, Pervasive Collaborative Networks, 9th IFIP TC 5 WG 5.5 Working Conference on Virtual Enterprises, Poznan, Poland, September 8-10, 2008, Springer IFIP Series Volume 283, pp.107-118,* 2008.
5	The virtual enterprise from a governance perspective, *D. Romero, A.I. Oliveira, L.M. Camarinha-Matos, A. Molina, in Proceedings of DoCEIS'10 – Emerging Trends in Technological Innovation, 1st IFIP WG 5.5/SOCOLNET Doctoral Conference on Computing, Electrical and Industrial Systems, Costa de Caparica, Portugal, February 22-24, 2010, Springer IFIP AICT Series Volume 314, pp.73-82,* 2010.
6	Negotiation and contracting in collaborative networks, *A.I. Oliveira, L.M. Camarinha-Matos, in Proceedings of DoCEIS'10 – Emerging Trends in Technological Innovation, 1st IFIP WG 5.5/SOCOLNET Doctoral Conference on Computing, Electrical and Industrial Systems, Costa de Caparica, Portugal, February 22-24, 2010, Springer IFIP AICT Series Volume 314, pp.83-92,* 2010.
7	Electronic negotiation support environment in collaborative networks, *A.I. Oliveira, L.M. Camarinha-Matos, in Proceedings of DoCEIS'12 - Technological Innovation for Value Creation, 3rd IFIP WG 5.5/SOCOLNET Doctoral Conference on Computing, Electrical and Industrial Systems, Costa de Caparica, Portugal, February 27-29, 2012, Springer IFIP AICT Series Volume 372, pp.21-32,* 2012.
8	Collaborative Business Scenarios in a Service-Enhanced Products Ecosystem, *L.M. Camarinha-Matos, P. Macedo, F. Ferrada, A.I. Oliveira, in Proceedings of PRO-VE'12 – Collaborative Networks in the Internet of Services, 13th IFIP WG 5.5 Working Conference on Virtual Enterprises, Bournemouth, UK, October 1-3, 2012, Springer IFIP Series Volume 380, pp.13-25,* 2012.

9	Negotiation Support and Risk Reduction in Collaborative Networks, *A.I. Oliveira, L.M. Camarinha-Matos, in Proceedings of DoCEIS'13 – Technological Innovation for the Internet of Things, 4th IFIP WG 5.5/SOCOLNET Doctoral Conference on Computing, Electrical and Industrial Systems, Costa de Caparica, Portugal, April 15-17, 2013, Springer IFIP AICT Series 394, pp. 15-24,* 2013.
10	Collaborative Business Services Provision, *L.M. Camarinha-Matos, H. Afsarmanesh, A.I. Oliveira, F. Ferrada, in Proceedings of ICEIS'13 – 15th International Conference on Enterprise Information Systems, Angers, France, 4-7 July 2013, vol. 2, pp 380-390,* 2013. **Best paper award**.
11	Collaborative Environment for Service-enhanced Products, *L.M. Camarinha-Matos, H. Afsarmanesh, P. Macedo, A.I. Oliveira, F. Ferrada, in Proceedings of INDIN 2013 – 11th IEEE International Conference on Industrial Informatics, Bochum, Germany, July 29-31, 2013, pp.374 – 379, 2013*.
12	Interplay of Collaborative Networks in Product Servicing, *L.M. Camarinha-Matos, F. Ferrada, A.I. Oliveira, in Proceedings of PRO-VE'13 – Collaborative Systems for Reindustrialization, 14th IFIP WG 5.5 Working Conference on Virtual Enterprises, Dresden, Germany, September 30 – October 2, 2013, Springer IFIP Series Volume 408, pp.51-60,* 2013.
13	Integrated Care Services in Ambient Assisted Living, *L.M. Camarinha-Matos, F. Ferrada, A.I. Oliveira, J. Rosas, J.N. Monteiro, in Proceedings of HEALTHCOM 2013 - 15th IEEE International Conference on e-Health Networking, Application & Services, Lisbon, Portugal, October 9-12, 2013, pp 177-181,* 2013.
14	An approach for the Management of an AAL Ecosystem, *A.I. Oliveira, F. Ferrada, L.M. Camarinha-Matos, in Proceedings of HEALTHCOM 2013 - 15th IEEE International Conference on e-Health Networking, Application & Services, Lisbon, Portugal, October 9-12, 2013, pp 565-569,* 2013.
15	Supporting product-servicing networks, *L.M. Camarinha-Matos, F. Ferrada, A.I. Oliveira, H. Afsarmanesh, in Proceedings of IESM 2013 - 5th IEEE International Conference on Industrial Engineering and Systems Management, Rabat, Morocco October 28-30, 2013, pp.1-7,* 2013.
16	Negotiation Support in Collaborative Services Design, *A.I. Oliveira, L.M. Camarinha-Matos, in Proceedings of DoCEIS'14 – Technological Innovation for Collective Awareness Systems, 5th IFIP WG 5.5/SOCOLNET Doctoral Conference on Computing, Electrical and Industrial Systems, Costa de Caparica, Portugal, April 7-9, 2014, Springer IFIP AICT Series 423, pp. 13-20,* 2014.
17	Negotiation Support for Co-Design of Business Services, *A.I. Oliveira, L. M. Camarinha-Matos, in Proceedings of PRO-VE'14 – Collaborative Systems for Smart Networked Environments, 15th IFIP WG 5.5 Working Conference on Virtual Enterprises, Amsterdam, The Netherlands, October 6-8, 2014, Springer IFIP AICT Series Volume 434, pp.98-106,* 2014.
18	Collaborative Enterprise Networks for Solar Energy, L.M. Camarinha-Matos, *A.I. Oliveira, F. Ferrada, P. Sobotka, A. Vataščinová, V. Thamburaj, in Proceedings of ICCCT'15 -*

	IEEE International conference on Computing and Communications Technologies, 26-27 Feb 2015, Chennai, India, 2015.
19	Negotiation Environment and Protocols for Collaborative Service Design, *A.I. Oliveira, L.M. Camarinha-Matos, in Proceedings of DoCEIS'15 – Technological Innovation for Cloud-based Engineering Systems, 6th IFIP WG 5.5/SOCOLNET Doctoral Conference on Computing, Electrical and Industrial Systems, Costa de Caparica, Portugal, April 13-15, 2015, Springer IFIP AICT Series Volume 450, pp.31-41,* 2015. **Best paper award**
20	Supporting Collaborative Networks for Complex Service-Enhanced Products, *L.M. Camarinha-Matos, A.I. Oliveira, F. Ferrada, in Proceedings of PRO-VE'15 - Risks and Resilience of Collaborative Networks, 16th IFIP WG 5.5 Working Conference on Virtual Enterprises, Albi, France, October 5-7, 2015, Springer IFIP AICT Series Volume 463, pp. 181-192,* 2015.